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ABSTRACT

This guide contains 36 learning modules intended for use by technology teachers and students in grades 7 and 8. Each module includes a student laboratory activity and instructor's resource sheet. Each student activity includes the following: activity topic and overview, challenge statement, objectives, vocabulary/concepts reinforced, equipment/supplies, introduction and step-by-step procedure, and evaluation. Among the elements included in the instructor resource sheets are the following: activity topic, essential elements, overview, challenge statement, systems model, critical thinking skills reinforced, teaching tips, instructional strategy, equipment/supplies, evaluation key, support materials, modifications for special needs students, and illustrations. The following are among the module topics: technology as building blocks, technological assessment of new innovations, telecommunication, news production, standards, energy states, chemical energy, power transmission systems, magnetism, superconductors, infrastructures, self-sustaining habitats in alien environments, engineering materials and material properties, hazardous materials, bridge construction, devices to assist disabled persons, robots, and cleanup. Also included are guidelines for using the laboratory activity materials, instructional planning outlines and worksheets, and the common essential elements of an introductory technology course. Many of the modules are also appropriate for high school technology programs. (MN)

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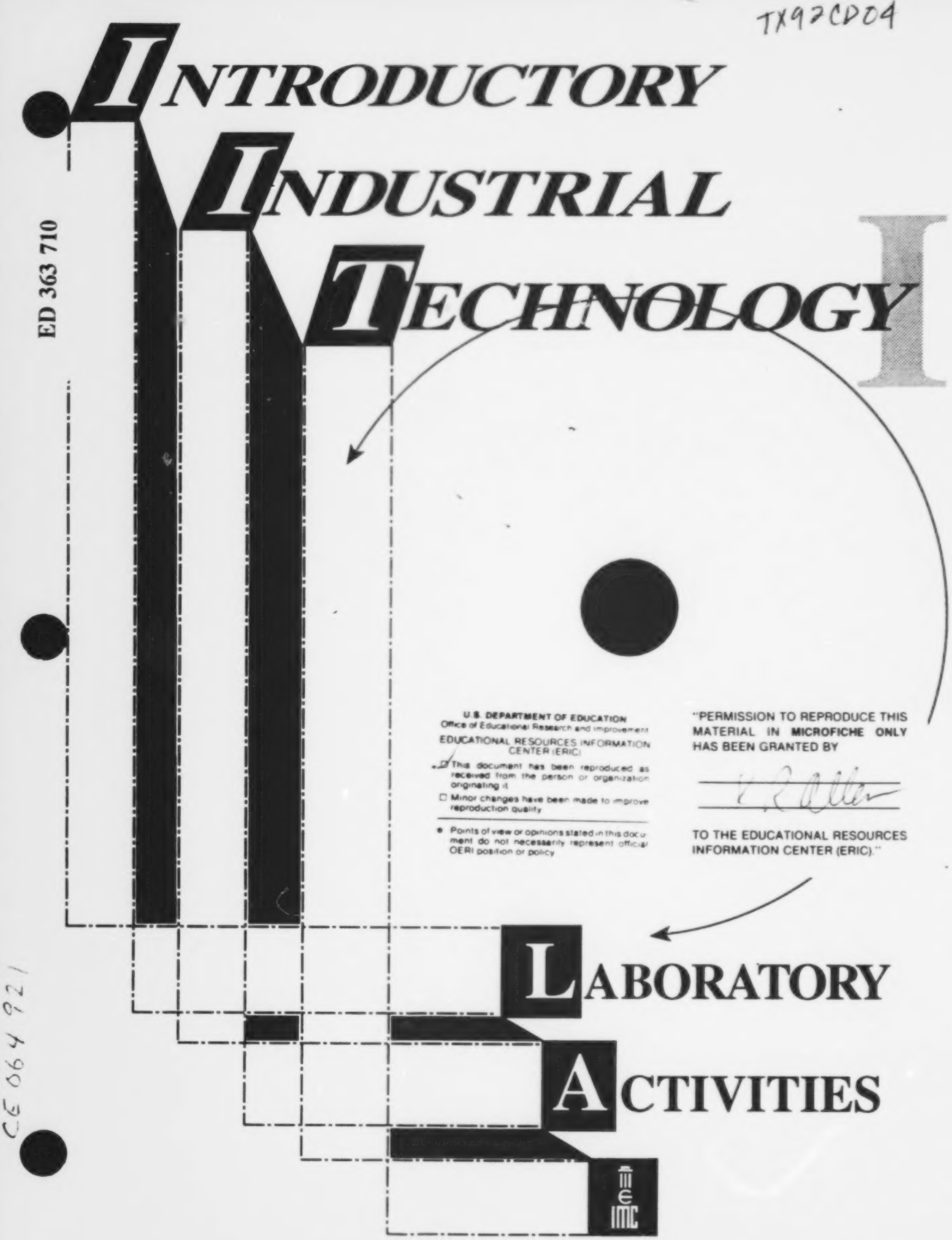

INTRODUCTORY INDUSTRIAL TECHNOLOGY I

LABORATORY ACTIVITIES

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INTRODUCTORY INDUSTRIAL TECHNOLOGY I

LABORATORY ACTIVITIES

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Technology Education Curriculum Specialist

Organization of the Laboratory Activity Materials

The major portion of the guide is the compilation of laboratory activity modules. The laboratory activity modules were developed, tested, and reviewed by technology teachers, supervisors, and teacher educators.

Each module includes (1) the student laboratory activity and (2) an instructor's resource sheet.

Each student activity includes the following elements:

- Student activity module number
- Activity topic
- Activity Overview
- Challenge Statement
- Objectives
- Vocabulary/Concepts Reinforced
- Equipment/Supplies
- Introduction (to the activity)
- Procedure (step by step)
- Evaluation

Each instructor's resource sheet includes the following elements:

- Instructor's resource sheet module number
- Activity topic
- Estimated time
- Essential Elements (common and specific)
- TAAS Objectives
- Activity Overview
- Challenge Statement
- Systems Model
- Interfacing with Other Disciplines
- Critical Thinking Skills Reinforced
- Teaching Tips
- Instructional Strategy
- Equipment/Supplies
- Evaluation Key
- Support Materials
- Modifications for Handicapped, Disadvantaged, and LEP (Limited English Proficient) Students—where appropriate
- Illustrations

Using the Laboratory Activity Materials

Intended Audience: The material in this guide is designed for use by technology teachers and students in grades seven and eight. Many of the modules, however, would also be appropriate and recommended for use by high school technology programs.

Length of Time for the Materials: The topic of study has been developed to provide materials for 18 to 36 weeks of study. Each module includes a suggested time frame for completion of the activity/module.

Benefits for Teachers and Students: The materials included in this guide were developed to assist technology teachers in planning, organizing, teaching, implementing, and evaluating a technology-based instructional program. The broad exposure students will receive by being involved in the laboratory activities in this guide will enhance their total educational program experience, including their problem-solving skills, creative thinking skills, and social interaction skills, as well as communication, computation, and technical skills.

Flexibility of the Materials: This guide, like other curriculum materials, does not attempt to encompass all situations. Therefore, teachers should supplement the guide with other appropriate ideas, information, and activities as needed in their particular programs.

A key feature in this guide is flexibility. The material may be used in the context of a large class/group approach, a small group approach where appropriate, and, in many of the modules, an individualized approach. In some of the modules, a combination of all three approaches might be incorporated.

Modules should be selected by the teacher in the order that he or she chooses, and the teacher is encouraged to expand or condense the student laboratory activity to meet the needs of addressing essential elements and the time frame designated to cover the topic. Teachers may also need to make substitutions in the use of each module, depending on the equipment, resources, and/or reference materials available.

Essential Elements/TAAS Objectives: Essential elements and TAAS objectives for reading, writing, and mathematics have been identified in each module (where appropriate). As used in this guide, essential element statements represent skills, knowledge, and/or attitudes that imply the ability or intelligence to accomplish an idea, problem, task, job, etc. Essential element statements will assist the teacher in clearly formulating the scope and sequence of the course of study and the purpose and processes for student learning.

Instructional Planning: An instructional planning outline and worksheet are included in the guide for teachers to use in their planning and preparation. The outline and worksheet should prove beneficial to teachers in enhancing their use of various instructional practices, in identifying appropriate teaching behaviors and process decisions, and in documenting teaching techniques selected.

Instructional Planning Outline

Domain I. Instructional Strategies

Criterion 1. *Provides opportunities for students to participate actively and successfully*
Indicator:
a. appropriately varies activities
b. interacts with students in group formats as appropriate
c. solicits student participation
d. extends students' responses/contributions
e. provides ample time for students to respond to teacher questions/solicitations and to consider content as it is presented
f. implements instruction an appropriate level of difficulty

Criterion 2. *Evaluates and provides feedback on student progress during instruction*
Indicator:
a. communicates learning expectations
b. monitors students' performances as they engage in learning activities
c. solicits responses or demonstrations from specific students for assessment purposes
d. reinforces correct responses
e. provides corrective feedback, or none needed
f. reteaches, or none needed

Domain II. Classroom Management and Organization

Criterion 3. *Organizes materials and students*
Indicator:
a. secures student attention, or students are attending
b. uses administrative procedures and routines which facilitate instruction
c. gives clear administrative directions for classroom procedures or routines, or none needed
d. maintains seating arrangements/grouping appropriate for the activity and the environment
e. has materials, aids, and facilities ready for use

Criterion 4. *Maximizes amount of time available for instruction*
Indicator:
a. begins promptly/avoids wasting time at the end of the instructional period
b. implements appropriate sequence of activities
c. maintains appropriate pace
d. maintains focus
e. keeps students engaged

Criterion 5. *Manages student behavior*
Indicator:
a. specifies expectations for class behavior, or none needed
b. uses techniques to prevent off-task behavior, or none needed
c. uses techniques to redirect off-task behavior, or none needed
d. uses techniques to stop inappropriate behavior, or none needed
e. uses techniques to stop disruptive behavior, or none needed
f. applies rules consistently and fairly
g. reinforces appropriate behavior when appropriate

Domain III. Presentation of Subject Matter

Criterion 6. *Teaches for cognitive, affective, and/or psychomotor learning and transfer*

Indicator:
- a. begins instruction/activity with an appropriate introduction
- b. presents information in an appropriate sequence
- c. relates lesson content to prior or future learning
- d. provides for definition of concepts and description of skills and/or attitudes and interests
- e. provides for elaboration of critical attributes of concepts, psychomotor skills, and/or attitudes and interests
- f. stresses generalization, principle, or rule as a relationship between or among concepts, skills, and/or attitudes/interests
- g. provides opportunities for transfer
- h. closes instruction appropriately

Criterion 7. *Presents information accurately and clearly*

Indicator:
- a. makes no significant errors
- b. uses vocabulary appropriate to students
- c. explains content and/or learning tasks clearly
- d. stresses important points and dimensions of content
- e. clarifies student misunderstanding, or none needed

Criterion 8. *Uses acceptable communication skills*

Indicator:
- a. uses correct grammar
- b. pronounces words correctly and clearly
- c. uses accurate language
- d. demonstrates skill in written communication

Domain IV. Learning Environment

Criterion 9. *Uses strategies to motivate students for learning*

Indicator:
- a. relates content to student interests/experiences
- b. emphasizes the value/importance of the activity or content
- c. reinforces learning efforts of students
- d. challenges students

Criterion 10. *Maintains supportive environment*

Indicator:
- a. avoids sarcasm and negative criticism
- b. establishes climate of courtesy and respect
- c. encourages slow and reluctant students
- d. provides praise for specific performance
- e. establishes and maintains positive rapport with students

Domain V. Growth and Responsibilities

Criterion 11. *Plans for and engages in professional development*

Indicator:
- a. shows progress in completing professional growth requirements as agreed upon with appraiser(s), or none needed
- b. stays current in content taught
- c. stays current in instructional methodology

Criterion 12. Interacts and communicates effectively with parents

Indicator:
- a. initiates communications with parents about student performance and/or behavior when appropriate
- b. conducts parent-teacher conferences in accordance with local district policy
- c. reports student progress to parents in accordance with local district policy
- d. maintains confidentiality unless disclosure is required by law

Criterion 13. Complies with policies, operating procedures, and requirements

Indicator:
- a. follows statutory and Texas Education Agency regulations
- b. follows district and campus policies and procedures
- c. performs assigned professional duties
- d. follows district promotion/retention policy and procedures

Criterion 14. Promotes and evaluates student growth

Indicator:
- a. participates in campus goal-setting for student progress
- b. plans instruction in accordance with district requirements
- c. documents students progress
- d. maintains accurate records
- e. reports student progress at appropriate intervals

Instructional Planning Worksheet

Essential Element(s): ____________________

TAAS Objective(s): ____________________

Curriculum Guide Page: ____________________

Objective: At the conclusion of the lesson, the student will be able to:

____

____

____

____

Focus Activity: ____________________

____

____

a. Task for lesson ____________________

____

b. Value of lesson to student is ____________________

____

Explanation / Check Understanding:

a. ☐ Lecture ☐ Overhead ☐ Demonstration ☐ ____________________

b. ☐ Curriculum Guide page _____ ☐ Text page _____ ☐ ____________________

c. Modeling (teaching will) ____________________

____

____

d. Key questions to check understanding:

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________

Guided Practice Exercise:

☐ Exercise copied from overhead ☐ Hand out worksheet no.________

☐ Copy from board ☐ Read sample problems ☐________

Checking Mastery (Learning Progress):

☐ View each student's work ☐ Students check and signal correct

☐ ________

Independent Practice (Reteach those needing help while others work):

☐ Worksheet No.________ ☐ Copy from overhead ☐ Copy from board

☐ Copy as dictated ☐ Reteach worksheet/outline number ________

☐ ________

☐ ________

Extension (Enrichment/Application):

☐ Worksheet no.________ ☐ ________

Describe how this activity makes relevant application of the lesson: ________

Closure: Restate the learning: ________

Method to involve the student in the summary: ________

Sponge Activities: Sponge focus activity no.________

Other sponge activity no.________

Introductory Industrial Technology
Common Essential Elements

(b) Introductory industrial technology shall include the common essential elements (grades seven-eight—1/2-2 units). The elements in this subsection are common to Introductory Industrial Technology I and II, grades seven-eight, and shall be included in each course. They are described here to preclude repetition. Every school offering these courses shall include the following common essential elements:

1. Leadership concepts and skills. The student shall be provided opportunities to:

   A. demonstrate skills, characteristics, and responsibitities of leaders and effective group members; and
   B. plan and conduct leadership activities using parlimentary procedures.

2. Concepts and skills related to successful employment and/or postsecondary training. The student shall be provided opportunities to:

   A. identify employment opportunities and preparation requirements;
   B. identify effective methods to secure and terminate employment;
   C. demonstrate productive work habits and attitudes; and
   D. describe the importance of taking pride in the quality of work performed.

3. Concepts and skills associated with entrepreneurship. The student shall be provided opportunities to:

   A. describe the risk and profit motive factor; and
   B. explain the role of small business in the free enterprise system.

4. Concepts and skills in the application of safety procedures. The student shall be provided opportunities to:

   A. demonstrate safe operation of selected tools, machines, and equipment; and
   B. maintain a safe and clean laboratory environment.

5. Concepts and skills related to planning, designing, and problem solving. The student shall be provided opportunities to:

   A. plan and design products to include working drawings and a complete bill of materials; and
   B. measure accurately using appropriate units.

6. Concepts and skills related to the tools, materials, and processes of technology. The student shall be provided opportunities to:

   A. solve problems by utilizing a variety of materials, tools, and equipment;
   B. select the most suitable processes to complete a task;
   C. identify conservation practices and methods in recycling materials of technology;
   D. investigate the interrelations of the systems of technology; and
   E. demonstrate the use of computers for simulation and application of technology.

7. Concepts and skills related to the past, present, and future of technology. The student shall be provided opportunities to:

   A. investigate ideas and technological developments of the past and present; and
   B. project how selected technological developments may impact future cultures and societies.

8. Concepts and skills related to evaluating products and services of technology. The student shall be provided opportunities to:

   A. recognize good design and construction; and
   B. evaluate products based on given standards or applications.

Introductory Industrial Technology I Essential Elements

(f) Introductory Industrial Technology I (grades 7-8—1/2-1 unit). Introductory Industrial Technology I is a laboratory-oriented course that includes the common essential elements for introductory industrial technology, plus the concepts and skills related to communication, energy, and production technology. The student shall be provided opportunities to:

1. apply sketching techniques to develop drawing format and graphic problem solving;
2. describe objects accurately through the principles of shape and size descriptions;
3. develop products using photographic materials and equipment;
4. design and produce graphic arts materials;
5. study the types and uses of communication systems;
6. use computer software to design and make drawings;
7. use computer software to solve problems in communication, energy, and production systems;
8. use apparatus and devices that demonstrate the generation, conversion, and control of mechanical, electrical, and fluid power;
9. construct models or use simulation devices that generate, convert, and control energy;
10. participate in activities involving transportation systems that move people, materials, energy, and information;
11. apply transmission systems that move energy by electrical, mechanical, and fluid technologies;
12. read and interpret maps, charts, and schedules;
13. apply organization and management techniques to planning, organizing, and controlling production processes in construction and manufacturing;
14. apply primary processes in manufacturing a product;
15. apply primary construction processes to building a structure;
16. explore the conversion of raw materials into finished products;
17. develop activities that involve research, design, production, and marketing of a product;
18. demonstrate techniques and processes used in automated production systems, to include robotics and computer numerical control (CNC); and
19. explore applications of communication, energy, and production technology in a space environment.

TAAS Objectives

English Language Arts

READING COMPREHENSION

Objective 1: Determine the meaning of words.
2: Identify supporting ideas.
3: Summarize written texts.
4: Perceive relationships and recognize outcomes.
5: Analyze information to make inferences/generalizations.
6: Recognize points of view, propaganda, and/or fact and nonfact.

WRITTEN COMMUNICATION

Objective 1: Respond appropriately to the purpose/audience in a written composition.
2: Organize ideas in a written composition.
3: Demonstrate control of the English language in a written composition.
4: Generate a written composition which develops and supports a central idea.
5: Recognize appropriate sentence construction.
6: Recognize appropriate word usage.
7: Recognize within the context of a written passage:
  a. the correct spelling of words
  b. correct capitalization
  c. appropriate punctuation

Mathematics

CONCEPTS

Objective 1: Demonstrate an understanding of the concepts of numbers.
2: Demonstrate an understanding of mathematical relations, functions, and other algebraic concepts.
3: Demonstrate an understanding of geometric properties and relationships.
4: Demonstrate an understanding of measurement concepts using metric and customary units.
5: Demonstrate concepts related to an understanding of probability and statistics.

OPERATIONS

Objective 1: Demonstrate skills, concepts, and applications related to addition.
2: Demonstrate skills, concepts, and applications related to subtraction.
3: Demonstrate skills, concepts, and applications related to multiplication.
4. Demonstrate skills, concepts, and applications related to division.

PROBLEM SOLVING

Objective 1: Estimate solutions.
2: Analyze problems and identify solution strategies.
3: Express problems using mathematical representations.
4: Evaluate the reasonableness of problem solutions.

TECHNOLOGY AS BUILDING BLOCKS

Essential Elements: 75.50(b): 2C, 2D, 6A, 6D, 7A, 7B, 8B
75.50(f): 7, 10
TAAS Objectives: Language Arts: RC 1-6; WC 1-4

Activity Summary

Your students will choose a simple product, determine the use, and break down the parts. Then, going back in time, they will determine all the concepts, materials, and discoveries that led to the invention of the product they chose.

Challenge Statement

Some people believe that technology began with the invention of the wheel. Others think it began with the idea of rolling flat surfaces over logs or the discovery of how to start a fire. Every product begins with a new concept, material, or need. Look around the room. Where did all these inventions begin? What do you think will be invented from the products we now use?

Through this activity, students will develop an understanding of the connectedness of technological inventions. They will see our current technology as building blocks to future developments.

Systems Model

Resources
Students as researchers, investigators, and futurists
Instructor as resource, moderator, and evaluator
Reference materials, bags, and boxes

Processes
Researching and reading information on the chosen product
Compiling information and clues about the product
Evaluation clues and making deductions about the product
Predicting future developments

Applications
Language arts research skills to technology activity
Deduction to breaking down the product
Creative imagining to future projections

Impact
Appreciation for and understanding of technology
Career choices
Creativity

Interfacing with Other Disciplines

Language Arts:	Students will read, research, and report on information regarding a product they choose.
Mathematics:	Depending on the products chosen, mathematics concepts may be discussed.

Science: Students will understand the importance of raw and synthetic materials to technology.
Social Studies: Students will understand the relationship of social needs to technology.

Critical Thinking Skills Reinforced

Students will compile and organize information about chosen products after reading and researching. They will evaluate and make deductions about clues from their classmates to guess the identity of a product. They will then make future projections about new products to meet the needs of society.

Teaching Tips

1. Make this activity fun by telling the students about the reward before they begin their research. This will give them something to work toward. You can put the prizes in a grab bag or assign a number to each prize, and have the winning student pick a number to determine his/her prize. The prizes can be candy, chips, or privileges (extra points, free time on the computer). You know what your students would like best.
2. Once the students choose their products, they can go to the library to do research. You can oversee their work to give you an idea of what products you want to choose for the game.
3. When you are reviewing the worksheets to choose products to be presented, be sure to assign two mature and reliable students to lead the brainstorming session.

Instructional Strategy

Through a simple guessing game, encourage your students to participate in reflective observation and abstract conceptualization. This will enhance technological literacy and develop an appreciation for the role of technology in society.

Equipment/Supplies

1. Boxes or bags to conceal products
2. Various products chosen by the class
3. Encyclopedias and various reference materials

Evaluation Key

Students will be evaluated on the originality, accurateness, and completeness of their Unfolding Technology worksheets.

Support Materials

Panati, Charles. *Panati's Browser's Book of Beginnings*. Boston: Houghton Mifflin, 1984.

Modifications for Handicapped, Disadvantaged, and LEP Students

Some students may require more time to research their products.

Unfolding Technology

My name is____

My product is____

Need/s met through this product are—

Concept/s that led to the invention are—

Materials discovered or developed and used in this product are—

Other products that led up to the development of this product are—

Considering new needs of society, new concepts we are realizing in science and technology, and new materials that are being discovered, new products that may be developed from this one are—

TECHNOLOGY AS BUILDING BLOCKS

Choose a simple product, determine the use, and break down the parts; then, going back in time, determine all the concepts, materials, and discoveries that led to the invention of this product.

Challenge Statement
Some people believe that technology began with the invention of the wheel. Others think it began with the idea of rolling flat surfaces over logs or the discovery of how to start a fire. Every product begins with a new concept, material, or need. Look around the room. Where did all these inventions begin? What do you think will be invented from the products we now use?

Objectives
- To realize the broad historic base of technology
- To understand the connection among concepts, materials, and needs in developing technology
- To understand that the technologies of today are the building blocks for technologies of the future
- To develop an appreciation of and interest in technology

Vocabulary/Concepts Reinforced
- Concepts
- Needs
- Materials
- Technology

Equipment/Supplies
- Boxes or bags to conceal products
- Various products chosen by the class
- Encyclopedias and various reference materials

Introduction
We can easily identify the *need* for developing the telephone as the need for communicating long distances. But we do not as easily realize that it traces back to the first communication forms, smoke signals and drums. How did the discovery of the voltaic battery in the late 1700s change communications?

The need to cross rivers and streams was an ancient transportation problem. Do you think the *concept* or idea of building bridges came from finding a tree that had fallen across the banks of a stream? The first bridge was built in 700 B.C. across the Euphrates River at Babylon, by fastening logs with twine to span the gap.

Some *materials* are discovered and found useful in raw form, like wood or iron ore. Others are developed to fill a particular need, like nylon, steel, and ceramics. Some are found accidentally as the result of other developments, like plastic, which was discovered in 1826 while developing a celluloid film for photography. Finding and developing new materials leads to new technology.

Needs, concepts, and materials are the source of all technology.

Procedure

1. Choose a product currently being used.
   a. Determine the reason it was made. What *need* was filled when this product was invented?
   b. Was a previous product modernized to make this product? What was it?
   c. What scientific or technological *concept* was developed to make this product possible?
   d. What is the origin of the *materials*?
2. Complete the Unfolding Technology worksheet, and submit it to your teacher for review. Your teacher will choose several products for the next step.
3. While your teacher reviews the worksheets, brainstorm the origin of the following products. Include the needs, concepts, and materials involved.
   a. Football
   b. Automobiles
   c. Pencils
4. If your product is chosen to give clues about, place it in a bag or box. If it is too large, or cannot be taken to school, put a picture of the product in a bag or box, and give the class a size description.
5. Read the information from the Unfolding Technology worksheet. Have the students guess your product. The winner will receive a reward from your teacher.
6. As other students read their Unfolding Technology worksheets and give clues, you may want to take notes to put all the clues together. Listen carefully so you can successfully guess the product and win the prize.

Evaluation

You will be evaluated on the originality, accuracy, and completeness of your Unfolding Technology worksheet.

TECHNOLOGY SETS THE STAGE

Essential Elements:	75.50(b): 1A, 2C, 2D, 4A, 4B, 5A, 5B, 6A, 6B, 6D, 8A, 8B 75.50(f): 1-4, 13, 14, 15, 17
TAAS Objectives:	Language Arts: RC 1, 2, 4, 6 Mathematics: C 1, 3, 4; O 1-4; PS 2, 4

Activity Overview
This activity is designed to create high visibility for the students in the school and community. The activity will teach the school and the community that technology is an integral part of all activities. This activity in reality is one in a network of high visibility activities which can result from forming a production company (designing and constructing sets, light systems, advertising, program printing, and video communication systems). There are no limits!

Challenge Statement
The fine arts classes (theatre arts, band, choir, art, journalism, etc.) and your Industrial Technology class would like to stage and/or tape programs (plays, concerts, video newscasts). You and your classmates must devise a way to fulfill these schoolwide needs.

Systems Model
Resources
Tools
Materials

Processes
Materials
Processing

Applications
Entrepenuership
Construction

Impact
Societal
Environmental
Site preparation
Community
Theatre

Interfacing with Other Disciplines

Theater Arts:	Production processess will be introduced.
Computer Literacy:	Flowchart development
Mathematics:	Measurement concepts

Critical Thinking Skills Reinforced

Students will organize a production company to research, design, and develop products for manufacturing. They will use problem-solving skills to come to an end product. They will evaluate technology systems and production processes.

Teaching Tips

1. Emphasize quality and craftsmanship in the construction of the flats.
2. Pinpoint and use students who are involved in the other electives.
3. Plan time for a mini-safety lesson on the pneumatic nailer.
4. Plan to expand the scope and length of these production company activities.

Instructional Strategy

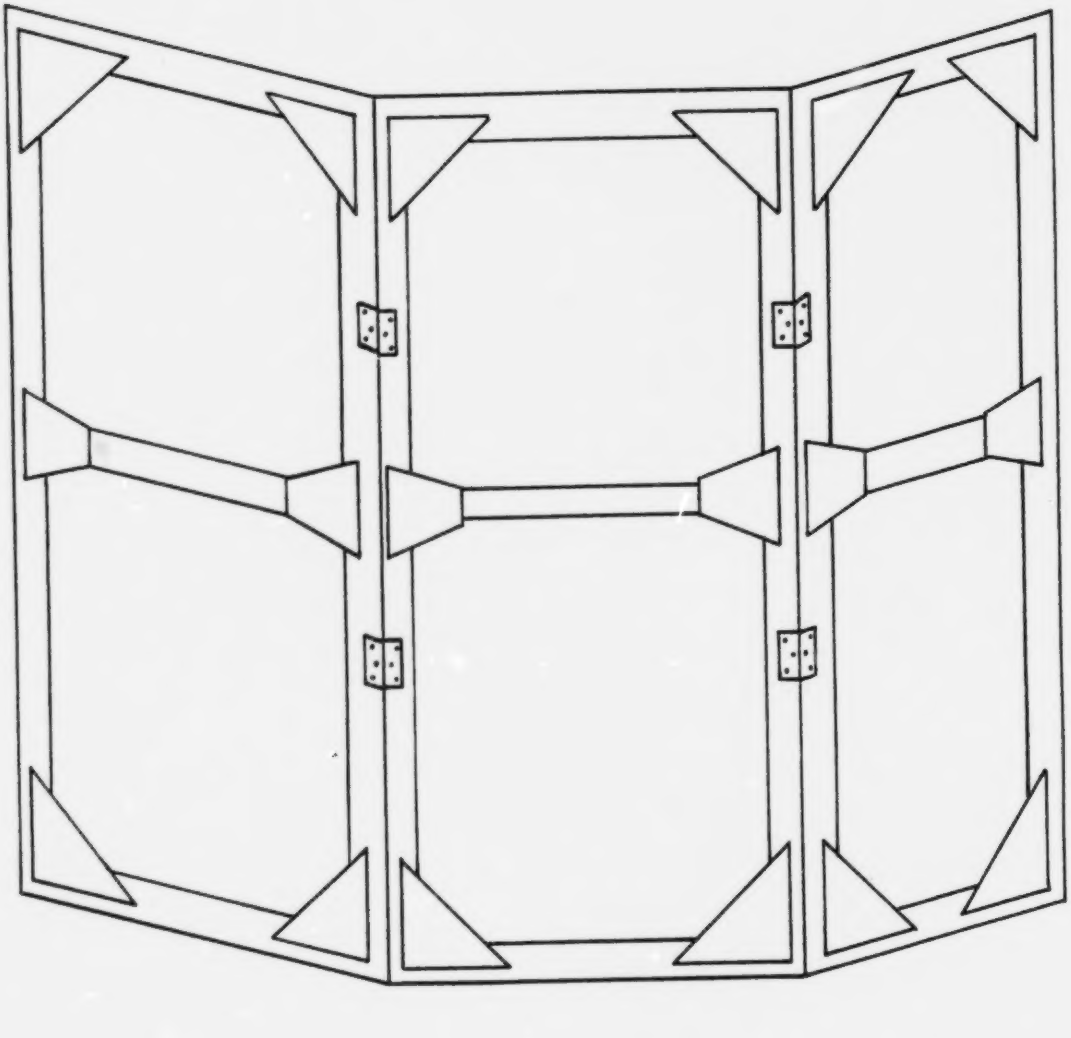
- Use a large group for setting up the company.
- Use small groups and/or cooperative learning for all other activities.

Equipment/Supplies

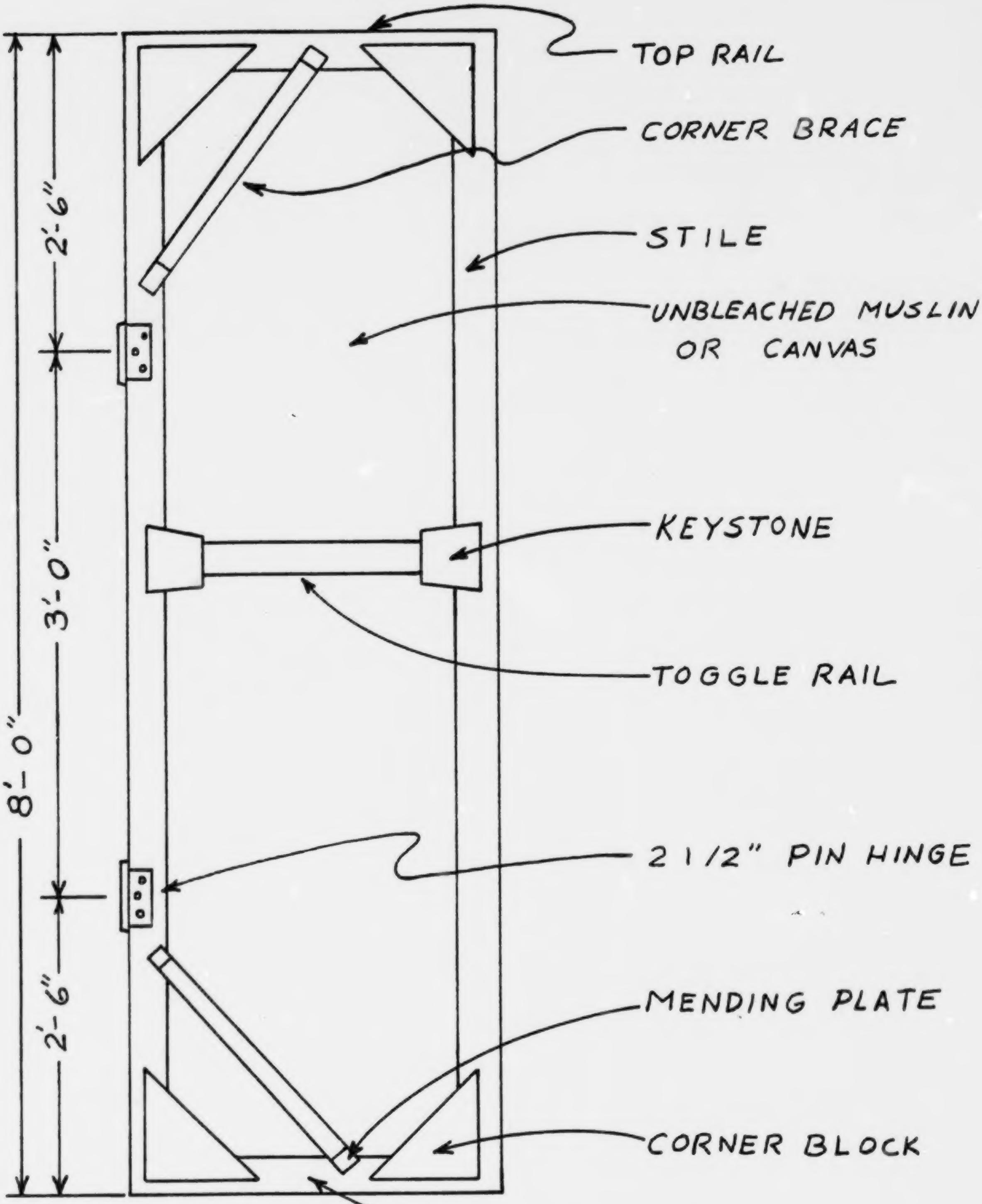
1. Pencil
2. Power mitre saw
3. Pneumatic nailer
4. Framing squares
5. Safety glasses
6. Staple gun/staple
7. Air compressor
8. Hammers
9. Fabric scissors
10. Two 1" × 4" × 8' #2 grade pine
11. Two 1" × 4" × 2' #2 grade pine
12. One 22-inch 1'- 1" × 4" × 1'- 10" #2 grade pine
13. Two 1" × 2" × 2' #2 grade pine
14. 35-40 1" finish nails
15. 8'-8" × 2'-6" piece of muslin
16. One 24" × 18" × 1/4" plywood
17. Nailing jigs
18. One 1/2" × 4' × 8' plywood (one per jig)
19. Various sizes of 1 × 2s and 1 × 1s
20. Jig/Production clamps
21. 8d nails
22. Clamps

Evaluation Key—Possible correct answers

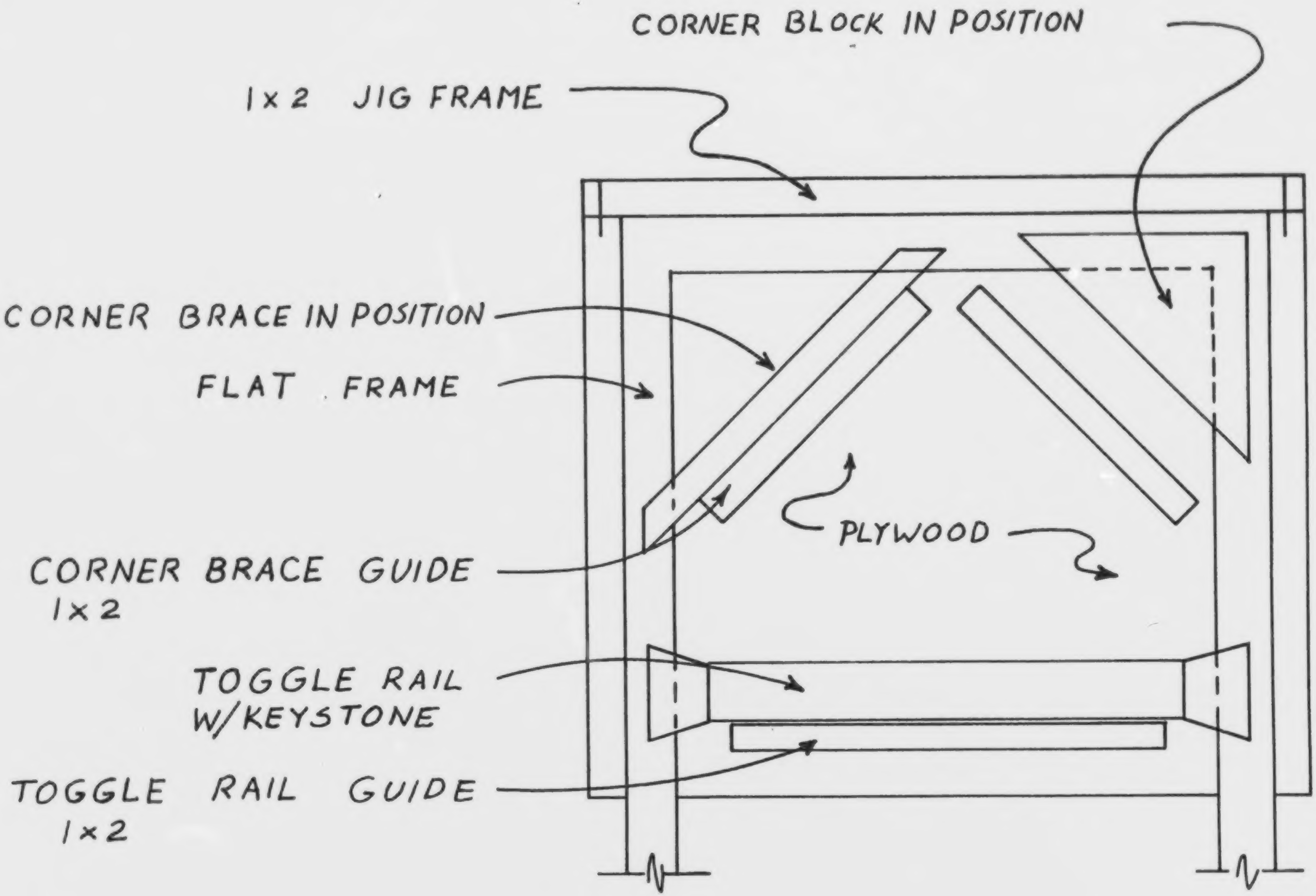
1. Tools, materials, money, time, information, energy
2. Design, research, materials processing, assembly
3. Answers will vary.
4. *Societal:* We provide goods and services for the school. We promote the performing arts. *Environmental:* We supply sawdust for compost. We affect the environment in indirect ways. We use lumber and cause damage to the environment through the logging industry. The use of fossil fuel when transporting our materials causes destruction of the ozone and pollution. We produce waste in our production process which is placed in a landfill.



BOOK


TOP RAIL
CORNER BRACE
STILE
UNBLEACHED MUSLIN OR CANVAS
KEYSTONE
TOGGLE RAIL
2 1/2" PIN HINGE
MENDING PLATE
CORNER BLOCK
BOTTOM RAIL
8'-0"
2'-6"
3'-0"
2'-6"

THE FLAT


CORNER BLOCK IN POSITION
1x2 JIG FRAME
CORNER BRACE IN POSITION
FLAT FRAME
PLYWOOD
CORNER BRACE GUIDE 1x2
TOGGLE RAIL W/KEYSTONE
TOGGLE RAIL GUIDE 1x2

A SUGGESTED JIG DESIGN

TECHNOLOGY SETS THE STAGE

With your classmates, form a production company and build stage sets and flats.

Challenge Statement

The fine arts classes (theatre arts, band, choir, art, journalism, etc.) and your Industrial Technology class would like to stage and/or tape progams (plays, concerts, video newscasts). You and your classmates must devise a way to fulfill these school wide needs.

Objectives

- To form a set production company
- To design and manufacture stage flats
- To construct sets

Vocabulary/Concepts Reinforced

- *Box set*—a two-wall or three-wall set composed of flats representing an interior or a room, often covered by a ceiling.
- *Brace*—an adjustable, polelike support for flats.
- *Corner block*—a triangular piece of plywood attached to each corner of the frame.
- *Flat*—a wooden frame covered with cloth used as the basic unit of structure of a box set.
- *Floor plan*—a drawing of the overhead view of a set showing the exact location of all entrances, walls, and furniture.
- *Jog*—a narrow flat.
- *Mitre joint*—any joint with pieces meeting at a 45° angle.
- *Rail*—the top and bottom pieces of a frame.
- *Stiles*—the side pieces of a frame.
- *Stop cleat*—a piece of metal or wood attached to the back or corner of a flat.
- *Toggle rail*—a piece of wood secured in the middle of the flat for strength.
- *Working drawing*—a detailed drawing showing how a piece of scenery is to be constructed.

Equipment/Supplies

- Pencil
- Power mitre saw
- Pneumatic nailer
- Framing squares
- Fabric scissors
- Two 1" × 4" × 8' #2 grade pine
- One 22-inch 1' - 1" × 4" × 1'-10" #2 grade pine
- 35-40 1" finish nails
- One 24" × 18" × 1/4" plywood
- Two 1" × 4" × 2' #2 grade pine
- Two 1" × 2" × 2' #2 grade pine
- One 8'-8" × 2'-6" piece of muslin
- Nailing jigs
- One 1/2" × 4' × 8' plywood (one per jig)
- Jig/Production clamps
- Clamps
- Various sizes of 1 × 2s and 1 × 1s
- 8d nails
- Safety glasses
- Staple gun/staples
- Air compressor
- Hammers

Introduction

Human beings have been putting on performances since ancient times. One way to communicate verbally and nonverbally is by performing. The Greeks used the theatre to communicate social and environmental information.

Sets and lighting are essential parts of a production whether it is on a stage or in a television studio. The application of technology in the performing arts is everywhere. Schools also use the theatre and other performance activities to communicate ideas and information. The production of these activities requires many types of technology.

Because a need for set structures, lighting systems, and electronic communication systems (sound systems, video systems, etc.) exists, you and your classmates will form a production company and provide the necessary technology systems.

Procedure

Company

1. Form a production company—incorporate.
2. Elect officers.
3. Set up departments.
4. Problem solve.
5. Assign tasks.
6. Research and develop products, and make work schedules and flowcharts.
7. Produce the product.
8. Check for quality control throughout the production.
9. Distribute the product.

Suggested Flat Jig

1. Create flat sketches. Choose one, and assign dimensions to it.
2. Create jig sketches. Choose one, and assign dimensions.
3. Measure, lay out, and cut the jig frame and guide pieces.
4. Measure, lay out, and cut the plywood.
5. Use a framing square and a pneumatic nailer to nail the frame and the guide to the plywood.

Flat Prototype

1. Make the patterns for the keystones and corner blocks.
2. Lay out and cut the stiles, rails, and brace pieces.
3. Lay out and cut the coner block, keystone, and mending plate pieces.
4. Place one rail piece and two stile pieces in the jig. Place the corner blocks over each corner. Clamp and nail into place.
5. Flip the flat frame around, and position a second rail piece between the two open stile pieces. Place the corner block piece in position, clamp, and nail.
6. Position the corner braces and mending plates in position, clamp, and nail.
7. Position the toggle rail and the keystones in position. Clamp and nail.
8. Lay out and cut the muslin.
9. Stretch the muslin accross the front of the frame. Fold the edges of the muslin around the back of the frame and staple.
10. Lay out and drill the pilot holes for the hinges.
11. Attach two hinges to each flat.

Evaluation
Answer the following questions with a brief complete sentence.

1. What were three resources that you used in the technological system?

____

____

____

2. What were three processes that you used in the technological system?

____

____

____

3. What are three applications for your production company?

____

____

____

4. What is the impact of your company?

Societal;______________________________

____

Environmental;______________________________

____

____

TECHNOLOGY ASSESSMENT OF NEW INNOVATIONS

Essential Elements:	75.50(b): 1A, 2C, 2D, 3A, 5B, 6B, 6D, 6E, 7B, 8B 75.50(g): 1A, 1F, 2E
TAAS Objectives:	Language Arts: RC 1-6; WC 1,-4 Mathematics: C 1, 2, 5; O 1-3: PS 1-4

Activity Overview

In this activity, your students will research new technological innovations, determine the positive and negative effects of an innovation, complete a technology assessment sheet, assign an assessment score, make recommendations for the safe use of the product, and assemble a poster board displaying all the information involved in the assessment.

Challenge Statement

How will the ability of scientists to duplicate human life in a test tube affect society? How will new chemical fertilizers and pesticides affect our water supply? How will a magnetic levitation transportation system affect mass transportation and the environment? Will the ultimate effects of these innovations be more positive or negative? Who will project the consequences and recommend safe uses for technological innovations?

This is an important unit as the students will be the inventors, designers, and manufacturers of the future. It is important that they realize the responsibility that individuals and industry have to society. This activity will help them objectively evaluate new technological innovations.

Systems Model

Resources

Students as researchers, evaluators, and reporters
Instructor as resource person, monitor, and evaluator
Current newspapers and magazines for technology reference

Processes

Reading and studying new information
Brainstorming effects of product or concept
Application of information to chart
Following instructions for poster assembly and presentation
Presentation of ideas and conclusions
Evaluation of presentations, concepts, and products

Applications

Analysis to technological innovations
Teamwork to end product
Transfer math and science knowledge to technological innovation evaluation
Formal evaluation to real world problems

Impact

Responsible innovations
Career choices

Problem-solving skills

Interfacing with Other Disciplines

Language Arts: Students will learn the meanings of new words, read about and apply new concepts, evaluate a product or concept, and report the findings in writing and orally.

Mathematics: Students will learn to assign a numerical value to the effects of a product or concept, and determine the overall value through a numerical denotation.

Science: From a science base, students will evaluate the short- and long-term effects of technological innovations on the earth and humanity. The technology instructor could work with the science teacher to research past inventions that have had the greatest effect on the environment.

Social Studies: Students will project and study the effects of technological innovations on society. The technology instructor could work with the social studies teacher to research past inventions that have had the greatest effect on society.

Critical Thinking Skills Reinforced

Though the analysis and evaluation of a product or concept, students will draw conclusions about the usefulness of the issue. They will read, research, brainstorm, project, calculate, and report information on their topic.

Teaching Tips

1. It would be helpful to have a copy of the OTA Directory. This can be obtained by writing the U.S. Congress, Office of Technology Assessment, Washington, DC 20510-8025, or you can call the OTA Publication Request Line at 202-224-8996.
2. Have transparencies of the illustrations and charts for instructions and discussion.
3. Encourage the students to follow directions carefully. Compare their work with the OTA, and relate the need for professionalism and accuracy in the congressional reports to their own work. Good work habits begin in school.
4. Encourage the students to take notes during reports. Take time to add any considerations the class may have about additional effects that were not listed.

Instructional Strategy

- Open the class by reading and discussing the Introduction.
- Review the Effects Wheel sample with the class before they research new technology.
- Monitor the class as they prepare their posters.
- Evaluate the students and their work.

Equipment/Supplies

1. A computer with a word-processing program is desirable but not necessary.
2. Paper and pen
3. Poster board

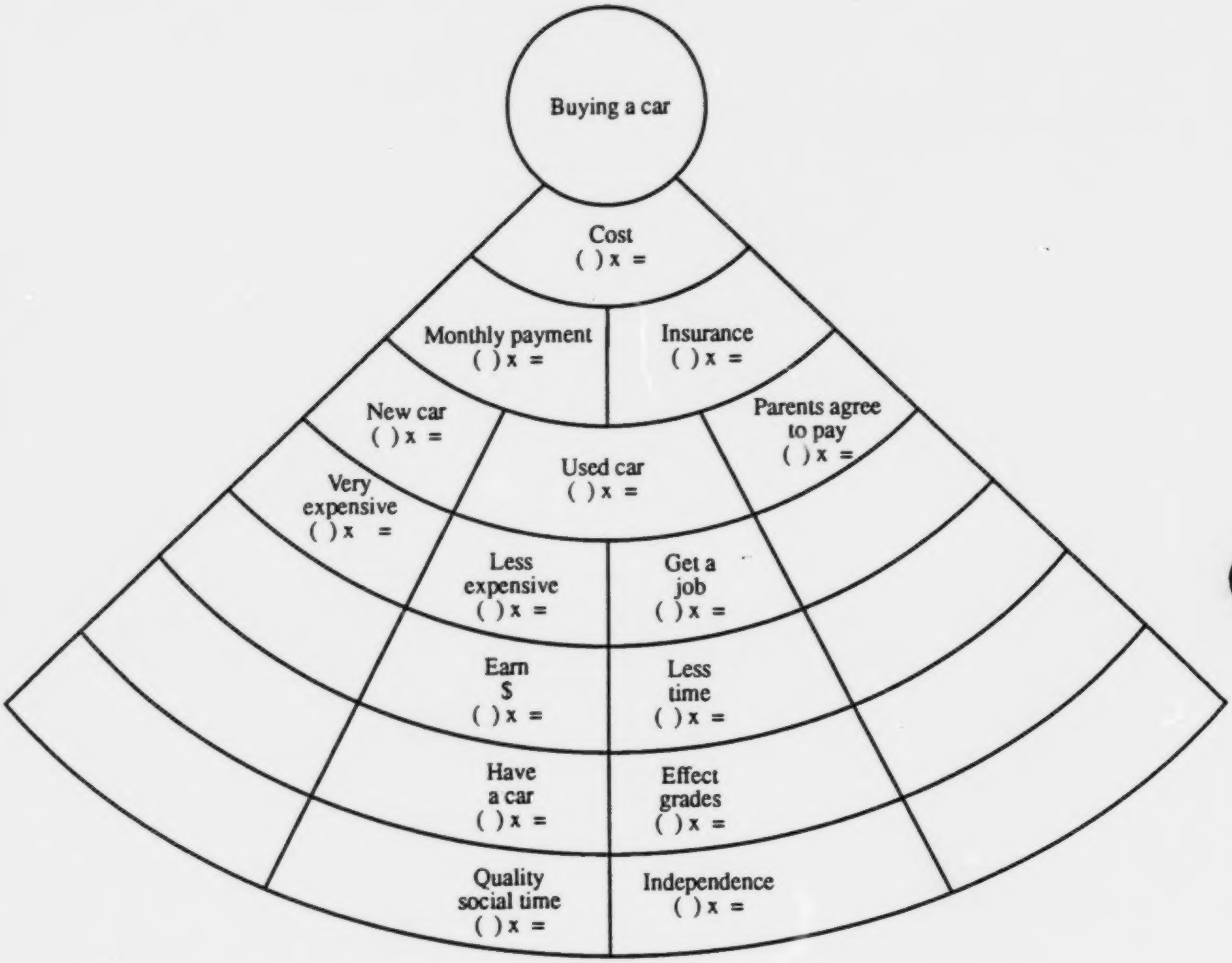
Evaluation Key

1. Evaluate each student in the group on participation and cooperation. Did he or she offer suggestions? Did he or she take the project seriously?
2. Evaluate the group on the quality and professional appearance of their poster. Did they follow directions? Is the information complete and accurate? Is the poster neat and well presented? Everyone in the group will receive one grade.
3. Grade your students on their oral presentation. Each student will receive the same grade for the group.

Support Materials

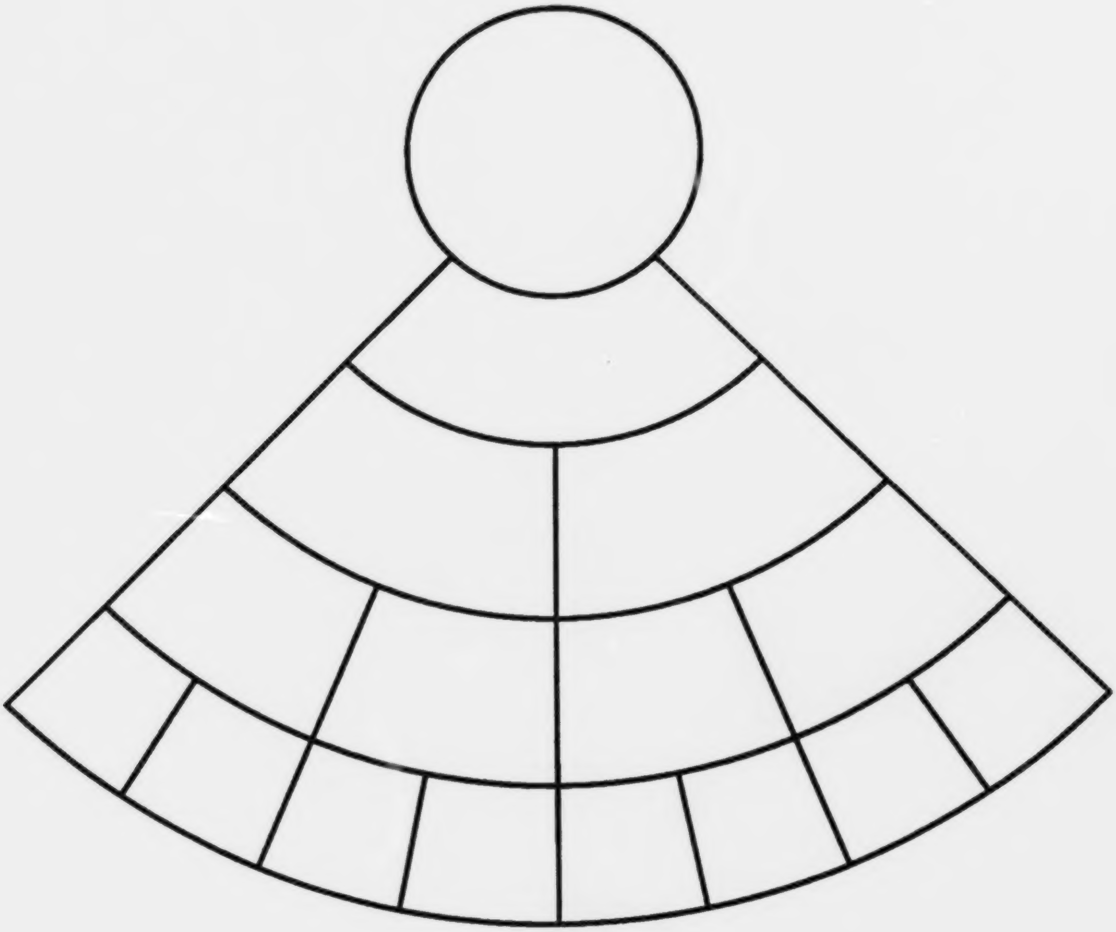
1. Congress of the United States
   Office of Technology Assessment
   Washington, DC 20510-8025
2. *Ties Magazine*. Drexel University, May/June 1991.
3. *The Technology Teacher*. September/October 1991.

Figure 1 Effects Wheel Sample Problem
Put the desirability values in the ( ).
Probability values in the open space.


Buying a car
Cost ( ) x =
Monthly payment ( ) x =
Insurance ( ) x =
New car ( ) x =
Used car ( ) x =
Parents agree to pay ( ) x =
Very expensive ( ) x =
Less expensive ( ) x =
Get a job ( ) x =
Earn $ ( ) x =
Less time ( ) x =
Have a car ( ) x =
Effect grades ( ) x =
Quality social time ( ) x =
Independence ( ) x =

How will you pay for gasoline? What other things would you add?

Figure 2 Effects Wheel Chart



Sample of Poster Layout

Title—Name of Innovation

A. Attach the description of the product or concept.

B. Attach the list of positive and negative impacts.

C. Attach either the Effects Wheel or a Cross-Impact Matrix sheet.

D. Post the Technology Assessment Score.

E. Attach the list of recommendations or requirements for safe use or implementation of the product or concept.

TECHNOLOGY ASSESSMENT OF NEW INNOVATIONS

Research new technological innovations, determine the positive and negative effects of an innovation, complete a technology assessment sheet, assign an assessment score, make recommendations for the safe use of the product, and assemble a poster board displaying all the information involved in the assessment.

Challenge Statement

How will the ability of scientists to duplicate human life in a test tube affect society? How will new chemical fertilizers and pesticides affect our water supply? How will a magnetic levitation transportation system affect mass transportation and the environment? Will the ultimate effects of these innovations be more positive or negative? Who will project the consequences and recommend safe uses for technological innovations?

Objectives

- To become acquainted with new innovations in technology
- To understand the need to assess the positive and negative impacts of technology
- To understand the role of the Office of Technology Assessment (OTA)
- To learn techniques used by the OTA
- To understand the obligation of responsible design and production

Vocabulary/Concepts Reinforced

- Technology assessment
- Effects Wheel
- Nonpartisan
- OTA
- FDA
- Technological innovations
- Primary Effect
- Secondary Effect
- Desirability Scale
- Probability Scale

Equipment/Supplies

- A computer with a word-processing program is desirable but not necessary.
- Paper and pen
- Poster board

Introduction

"The mechanical television system outlined suffers from a number of serious objections. Some of the important limitations are: (1) it is optically very inefficient; (2) mechanical components rotating at high speeds are involved; and (3) a high intensity light source which can be varied at high frequencies required for a good picture is very difficult if not impossible to realize in practice.

Obviously, such a distribution (of light) cannot be transmitted over a single electrical communication channel where the current or voltage transmitted is a function of time only."

This description was not taken from the 1800s, but from a 1958 encyclopedia! That is less than 40 years ago. Television is just one example of the fast pace of technological developments. We take television for granted now with dozens of stations and satellite broadcasts from around the world. No one could have predicted the impact of television on our communication system and on society.

In the 1940s, a chemical pesticide called DDT was released. By 1967 more than 170 species of pest became resistant to the poison, but more importantly, DDT was found to be a major pollutant in our water supply from domestic and industrial runoff. Since then, DDT has been legally banned.

DDT is just one example of a development that initially appeared to be of great value, but was actually found to be more of a threat to society. Because we have not always considered the long-term effects of technology, we are suffering from the results of misguided decisions. With all technological developments, there are going to be both positive and negative effects. We must weigh the effects according to a number of different criteria. Social and economic considerations are obvious, but we must also consider employment, educational, environmental, religious, and moral concerns.

Ideally, the long-term effects will be considered before a concept or product is developed and marketed. One agency that approves the use of new drugs and medicines and new food preparation processes is the FDA, the Food and Drug Administration. The Office of Technology Assessment (OTA) was formed to research other, industry-related issues.

The OTA was formed as a congressional agency in 1972 to provide sound, nonpartisan information to Congress about technological innovations. They employ about 200 full-time workers, who hold their positions for 4 to 6 years. They also offer six fellowship positions each year to writers who are willing to live in Washington, D.C., and compile highly technical information in a simple readable form. OTA also hires about 2,000 private contractors to conduct research in different areas. All these people and a $20 million budget allow the OTA to provide a valuable service to our country.

The issues to be investigated are generated by a congressional committee consisting of six Democrats and six Republicans. Most studies are completed in 10 to 24 months. Some more complex cases could take up to 4 years. Some of the more complex cases the OTA has studied are the greenhouse effect, acid rain, toxic waste production and disposal, and manufacturing in the United States.

The end result of each study is a clearly written report published in booklet form. These publications are public information and can be easily ordered by phone or mail.

How to Conduct a Technology Assessment

An assessment can be made using an Effects Wheel chart. The Effects Wheel is used to look at one specific innovation or development and weigh the effects that result like the ripples in a pond when a rock is thrown. The topic or product is listed, then the obvious results, then the effects of those results, and so on. Study figure 1.

After research has been done on a topic, the positive and negative effects must be weighed. A desirability scale helps us weigh the effects.

Desirability Scale

Highly desirable = +10
Desirable = +5
Acceptable = 0
Not desirable = -5
Very undesirable = -10

Some effects may be highly desirable, but very unlikely to occur. In that case it would not make sense to recommend a desirable product or concept, if it was not likely to be of use. Because of that, a probability scale was devised.

Probability Scale

A certainty = 5
Very likely = 4
Probable = 3
Just possible = 2
Not likely = 1
Unknown = 0

Each effect is assigned a desirability and a probability value. Multiply the probability value by the desirability value to determine the overall value of the effect. Once the overall value is calculated, you can determine the impact of the effect. Calculate the total number by adding up the values in the last ripple. If the overall number is positive, the idea or product is a good one, if it is negative, it is not a good idea or product and needs revision.

Procedure

1. Read and study the Introduction and the Vocabulary. Fill in the desirability and probability values for each item in figure 1, "Effects Wheel Sample Problem." Would you buy a car?
2. Discuss the importance of the Office of Technology Assessment to industry and society. Discuss situations that could have been avoided if the OTA had made an assessment and recommendations. If your teacher has the directory of its publications, review the topics, and call OTA's Publication Request line (202-224-8996) to request summaries of specific topics.
3. Read current newspaper and magazine articles to identify current technological innovations. List innovations on the board. This will be your class list of topics to assess. Your teacher will divide the class into groups of four to six students and assign an innovation to assess just as the Congress assigns the OTA.
4. Just as the OTA has deadlines for their assessments, you will be given two days to complete the following reports and assemble the poster board. Your group will follow the instructions in each of the areas described below and complete a neatly written summary of information to display on a poster. (See sample form.) Use a computer to write your report if one is available.
    a. Gather all the information you can about your topic. You may find a great deal about your topic or only a small amount. Summarize the information, and write a report that includes—
        (1) a description of the product or concept;
        (2) sketches of the product, if possible. If there is a picture in a magazine, make a copy and include it in your report;
        (3) the purpose of the product or concept; and
        (4) a description of how the product is manufactured or how the concept will be implemented.
    b. Brainstorm all the positive and negative effects of your innovation. Neatly compile the information in a two-column list labeled "Positive Effects" and "Negative Effects." Title the page with the name of the innovation.
    c. Complete an Effects Wheel for your innovation. Be sure to include the numerical values your group agreed on for each area. You must agree on the desirability and probability values.
    d. Total the technology assessment score to post it in large print on the poster board under the Effects Wheel.

   e. List the recommendations or requirements for safe use or implementation of the product or concept.
5. Assemble your poster display. Be sure all of your names are on the back of the poster.
6. Each group will give an oral report of the information on the board. Listen carefully as other groups give their reports. Jot down any additional positive or negative effects you think of for their topic.
7. Discuss all the assessments. Which product or concept scored highest? Which scored lowest? Did you agree with the assessments from the other groups? Why? Would you be a good committee member on the OTA? Why?

Evaluation
1. You will be evaluated on how well you worked in your group. Did you offer suggestions? Did you take the project seriously?
2. You will be evaluated on the quality and professional appearance of your poster. Did you follow directions? Is the information complete and accurate? Is the poster neat and well presented? Everyone in your group will receive one grade.
3. You will be graded on the oral presentation of your work. Everyone in your group will receive the same grade.

TELECOMMUNICATION

Essential Elements:	75.50(b): 1A, 2C, 2D, 3A, 4B, 6A, 6B, 6D, 6E, 7A, 7B, 75.50(f): 5, 7, 10
TAAS Objectives:	Language Arts: RC 1-6; WC 1-4

Activity Overview
Your students will compile a short informative message. After you approve their message, they will determine how to send it using five different types of telecommunication.

Challenge Statement
Hundreds of years ago, people could communicate with smoke signals from hill to hill or with drumbeats across a valley. Technically, that was the beginning of long distance communication. Now, accurate communication using those methods would be impossible. Satellites have made communication accurate and instant. The question now is which form of communication is best for the message?

Communication is becoming more sophisticated with advances in technology. Your students probably take communication for granted and are unaware of all the different methods available for personal use and business.

This activity will broaden their awareness and help them understand communication as another area of technology.

Systems Model
Resources
Students as learners and communicators
Teacher as resource person and moderator
Communication supplies and equipment

Processes
Reading and discussing new information
Applying various forms of telecommunication
Evaluating types of telecommunication
Projecting future communications methods

Applications
Information to telecommunication systems
Telecommunication methods to knowledge of communications systems
Imagination to future communication

Impact
Students' understanding of communication
Future of communication
Career choices

Interfacing with Other Disciplines

Language Arts:	Students will learn new words and concepts and apply concepts to modern telecommunication methods.
Social Studies:	Students will understand the impact of communication on society. They will realize that different types of communication are appropriate for different information.

Critical Thinking Skills Reinforced

Students will compare and analyze different methods of telecommunication. They will plan various messages which are appropriate for each method and send the message to an audience. They will then imagine communication of the future.

Teaching Tips

1. Get information on the cost of telegraphs in your area and guidelines for sending messages. If possible, get blank forms for your students.
2. Students in each group can videotape the TV message and tape-record the radio message. If you have a FAX machine in your school, arrange to send a message to another school or a student's parent or your spouse at work. Depending on your computer situation, either keep the message within the lab, or send it to another area in the school. The students would not need to actually send a telegram, but can fill out the form and calculate the cost.
3. Make the experience as real as possible using your facility and equipment so your students can evaluate each method accurately. Emphasize the advantages and disadvantages of each method during the evaluation process.

Instructional Strategy

- Encourage application and transferability by creating a realistic telecommunication simulation activity.
- Monitor and encourage students throughout the activity to analyze each method.
- Stimulate creative imagining through brainstorming future communication methods.

Equipment/Supplies

1. Telephone
2. TV
3. Tape recorder
4. Computer
5. Video camera
6. FAX machine if available

Support Materials

1. Post, Paul E. "Personal Telecommunications," *The Technology Teacher,* May/June 1991, 9-14.
2. "Telecommunications," *The Technology Teacher,* November 1988, 15-21.

Modifications for Handicapped, Disadvantaged, and LEP Students

No modifications are necessary.

Telecommunication Activity Sheet

People in our group are____

____

Our first message is "____

____

____"

1. Is your message appropriate for all forms of telecommunication?____________________
2. Circle the forms that were appropriate for your message.

   (1) telephone (2) TV (3) telegram

   (4) FAX (5) computer (6) radio
3. Why was your message appropriate for the forms you circled?____________________

   ____

   ____
4. Why was it inappropriate for the other types of telecommunication?________________

   ____

   ____
5. Record your group's message for each type of telecommunication. (Write on back for more space.)

(1) telephone____

____

(2) TV(video camera)____

____

(3) telegram____

____

(4) FAX (if available)____

____

(5) computer____

____

(6) radio (use a tape recorder)_______________________

____

TELECOMMUNICATION

Compile a short informative message in your group, then determine how to send it using five different types of telecommunication.

Challenge Statement

Hundreds of years ago, people could communicate with smoke signals from hill to hill or with drum-beats across a valley. Technically, that was the beginning of long distance communications. Now, accurate communication using those methods would be impossible. Satellites and computers have make communication accurate and instant. The question now is which form of communication is best for the message?

Objectives

- To learn the meaning of telecommunication.
- To become aware that there are many forms of telecommunication.
- To understand the advantages and disadvantages of each form of telecommunication.
- To prepare and send a message through various forms of telecommunication

Vocabulary/Concepts Reinforced

- Telecommunication
- Data communication
- Image communication
- Telegraph
- Audio visual communication
- Voice communication
- Message communication
- Electromagnetic transmission

Equipment/Supplies

- Telephone
- TV
- Tape recorder
- Computer
- Video camera
- FAX machine if available

Introduction

Human communication is one of our most natural traits. Beginning with our first "goo-goo," we wanted to talk to the people around us. We use communication to stay informed about everyday occurrences, to keep in touch with friends, to learn new things, and for entertainment.

With the advent of satellites and computers to communication, we rely on instant information from all parts of the world. Telecommunication makes this possible.

Although the word *telecommunication* did not appear in the dictionary until the 1960s, telecommunication started in 1837 with the demonstration of the telegraph. Two characteristics are necessary to make a communication "telecommunications." The first requires that the information be sent over distance, and second, that the message be sent electromagnetically.

There are five types of telecommunication currently being used. The first is *voice communication,* which includes, telephones, walkie-talkies, CB radios, and VHF radio-telephones. Second is *audio-video communication,* which includes both a voice and an image. The most common form is TV. *Data communication* is the third type, and relies on transmissions from one computer to another, commonly used between banks, airlines, and credit card companies. Fourth is *image communication* in the form of facsimile (FAX). The fifth type is *message communication*, commonly sent through radio and newspapers.

We are least familiar with data communication systems, which are widely used in business and industry. Microcomputers are being expanded as a major communication tool. Microcomputers link people together through electronic mail, information transfer, and computer conferencing, and provide access to a variety of resources from databases to supercomputers.

From 1837 to 1876, the only form of telecommunication was the telegraph. This provided the opportunity to send short, one-way communication over areas where lines were available. In 1876, telecommunication was changed forever with the introduction of the telephone. A major advantage of the telephone is that it is a two-way system that allows the receiver to hear the message in the sender's voice. Questions can be answered immediately, and there is no concern that the receiver did not get the message, as with the telegraph.

Radio and television brought a different form of communication that involved a mass message and entertainment system that was not intended to be two-way communication. The message was sent to a large number of people with no intention of receiving a return message. It is an impersonal communication form intended to inform, persuade, or entertain. The main purpose is commercial.

The technology age brought data and image communication mainly for business purposes. FAX machines are a necessity to send written information quickly across long distances. Writing skills are required to communicate properly through FAX (and computers). Graphs, pictures, sketches, and signatures can be sent instantly. Before FAX machines, this information had to be mailed and took several days to receive. The machine indicates the message has been sent, and a reply can be sent immediately. The same types of information can be sent through computers that are networked, but the cost of networking requires that there be a need for continuous exchange, not occasional correspondence.

Procedure

1. Read and discuss the Introduction. List the types of telecommunication on the board, and list common uses for each form.
2. Your teacher will divide the class into groups. Compile *one* message to send by each method:
   (1) telephone (2) TV (3) telegram
   (4) FAX (5) computer (6) radio
   Fill out the Telecommunication Activity Sheet. Share your message and evaluation with the class.
3. Design an appropriate message for each of the six types of telecommunication. Write the messages on the Telecommunication Activity Sheet. Use the supplies your teacher provides, and send the message to another group or class.
   (1) telephone (2) TV(video camera) (3) telegram
   (4) FAX (if available) (5) computer (6) radio (Use a tape recorder)
4. How effective was the type of communication for the message? Has the ideal form of communication been developed yet? Discuss the ideal form of communication.

Evaluation

You will be graded on your participation and ideas during the class discussions and group activity. You will also be graded on the neatness and accuracy of the Telecommunication Activity Sheet.

WHO AM I?

Essential Elements:	75.50(b): 2C, 4A, 4B, 6A, 6B, 8B 75.50(f): 3
TASS Objectives:	Language Arts: RC 2, 4, 5, 6 Mathematics: C 1

Activity Overview
The students will use basic photography processes to photograph and print still pictures of various parts of their body without revealing their faces. The photos will be displayed, and other students will try to identify the photographer in the pictures.

Challenge Statement
Students should gain awareness of using visual images and their own creative ability to perceive relationships and recognize outcomes. They will understand a different use for photography.

Systems Model
Resources
Students as models and photographers
Teacher as resource and monitor
Photographic supplies and equipment

Processes
Planning subject for exposure
Photographing subject
Developing negatives and prints
Laying out exposures
Analyzing prints to students

Application
Photographic skills and processes to photographic game
Artistic perceptions to layout

Impact
Understand the power of photography

Interfacing with Other Disciplines

Language Arts:	Students will perceive relationships, recognize outcomes, and learn to analyze information to make inferences and draw conclusions.
Mathematics:	Students will use their math skills in printing and laying out their pictures, and in mixing chemicals if possible.
Science:	Students will work with chemicals in developing film and prints.
Social Studies:	Students will become more aware of the complexity of human beings.

Critical Thinking Skills Reinforced

Photography students will design and implement a visual composition to conceal their identities. They will apply photographic principles to the problem. In guessing another student's identity, the students will analyze and evaluate the "evidence" to draw a conclusion about the photographer's identity.

Teaching Tips

1. The students must be familiar with photographic processes to complete this human beings.
2. Be very careful in previewing negatives and contact sheets that the pictures are appropriate for all audiences.
3. Students will need to use a 35mm camera, cable release and or timer, and a tripod. A macro lens will come in handy for this assignment.
4. Provide the students with a large envelope or folder to conceal their photos. The students may be able to make an envelope.

Instructional Strategy

- Begin the unit with a review of the photographic method. The activity is designed to enhance instruction.
- Present the problem-solving situation to the students, and allow them to use their creative energies to design a solution.
- Allow the students to investigate the evidence and use the discovery method to come to a conclusion.
- Close the activity by revealing the identities of the photographers and evaluating their prints.

Equipment/Supplies

1. 35mm camera and tripod
2. One roll (or more) of B&W film, 24 exposures
3. Basic darkroom
4. 5x7 Photo paper
5. Standard poster board
6. Tape and glue

Evaluation Key

Students will be evaluated on the quality of B&W prints, the composition of photos, and the overall creative presentation of clues.

Support Materials

Basic photo text

Modifications for Handicapped, Disadvantaged, and LEP Students

LEP students should have no problem in completing this photo assignment. Handicapped students should pair with a nonhandicapped student if it seems needed. As always, caution should be exercised around chemicals.

WHO AM I?

Take pictures of parts of your own body without revealing your face, and display them on a poster board for other students to identify. Your goal is to stump your audience by hiding your true identity.

Challenge Statement

"A picture is worth a thousand words" is a true statement. Photography is used in many different ways. One is in piecing information together to gather clues or prove theories. Law enforcement officers and scientist often use photography for this purpose. You will give clues to your identity through photography.

Objectives

- To shoot, process, and print black-and-white film and paper using basic photographic techniques
- To shoot self-portraits of parts of your body in a creative and tasteful manner
- To lay out six photographs in a way to give clues while hiding your true identity
- To use photographic clues to determine the identity of other students

Vocabulary/Concepts Reinforced

- Composition
- Center of interest
- Photographic quality
- Creative stimulation
- Laying out a planned procedure
- End result objective
- Deadline

Equipment/Supplies

- 35mm camera and tripod
- One roll (or more) of B&W film, 24 exposures
- Basic darkroom
- 5×7 photo paper
- Standard poster board
- Tape and glue

Introduction

When we think of taking pictures, we generally relate them to vacations, birthdays, or other special occasions. We see pictures all the time in newspapers and magazines for advertising or news reporting, but photography is used for much more.

When a crime takes place, law officers will take pictures of even the smallest details to study for clues to the crime. Insurance investigators will take pictures to determine the amount of a claim and to document the damage. Scientists use photography to identify plants, animals, and minerals and to describe them for future use. One way medical personnel use photography is by recording visible symptoms so diseases can be more easily identified. You can look through any family medical book and see these visual depictions.

You are going to use photography, not for entertainment, but for clues!

Procedure

1. Determine which photos will be taken and the layout before you load your camera. Examples you may consider are your hand, chin, elbow, eye, arm, knee, foot, toes, fingers, ear, and so on. These body parts should be approved by your instructor. Remember, you should not have a full face in any of these pictures. You should try and shoot these pictures by yourself without the help of any other student, but if you need help, ask someone who will not give you away.
2. After deciding how you are going to shoot your clue pictures, load a roll of black-and-white film (24 exposures) into your 35mm camera and, with a tripod, make your exposures. Work to achieve good exposure, focus, and composition.
3. After shooting your roll of B&W film, process it, and allow it to dry. Develop a contact sheet of the negatives to be graded and approved by your instructor.
4. Choose six pictures from the contact sheet. Remember to look for good exposures, focus, and photographic composition. (Do the best you can at keeping the pictures hidden from the other students.)
5. Using proper photographic techniques, expose the six negatives, and develop the prints.
6. Place your six best exposures on the poster board at random, keeping in mind good layout. Letter the words "WHO AM I?" somewhere on the board. Include a sign-up sheet so other students can have the opportunity to identify the photographer. (Only the instructor should know who the photographer really is.)
7. Each mystery photographer board should be displayed in an area of the classroom with a sign-up sheet so other students can record their guess of the photographer. Those who are not guessed accurately could be displayed so the entire school can guess.
8. Turn in your mystery photographer board to your instructor.
9. Try to guess the identities of your classmates.

Evaluation

You will be evaluated on how well the photos meet the criteria of discretely and appropriately revealing your identity, quality of B&W photos (contrast and focus), composition, exposure, overall display of pictures, and use of creative ability.

NEWS PRODUCTION

Essential Elements: 75.50(b): 1A, 2A, 2C, 2D, 4A, 4B, 6A, 6B, 6C, 7A, 7B, 8A
75.50(f): 5, 12, 17
TAAS Objectives: Language Arts: RC 1-6; WC 1-7

Activity Overview

Students will write a script, build props, and film a 20- to 30-minute news production. The production will include local, state, and national news. Each news portion must include one environmental issue and one social issue. The production will also include sports and weather.

Challenge Statement

This activity will allow your students to research environmental and social issues as a means to an end. The students will have the advantage of researching, relaying, and receiving information that is part of our essential elements, concealed in a more interesting format. They will be able to determine the effect telecommunication has on the public, and to learn how television programs are prepared off-camera.

Systems Model

Resources
Instructor as discussion moderator, resource person, and monitor
Students as researchers, planners, script writers, props people, presenters, film crew, audience, and evaluators

Processes
Teamwork and group planning of research and presentation
Research of materials for news presentation
Planning of research and presentation
Presentation of materials
Electronic processing of video/audio news production
Observation and evaluation of news presentation
Gathering information from presentations

Applications
Research to broadcasting
Teamwork to a finished product
Telecommunication to society through the news
Current information to daily life

Impact
Recycling as a personal responsibility
Veiwing the news as fact or opinion
Understanding of the expanded process of telecommunication
Knowledge of career options in communication

Interfacing with Other Disciplines

Language Arts:	Students will research a new topic, while learning new vocabulary, to write and present a newscast. They will meet all TAAS objectives for language arts through this activity.
Mathematics:	Students will make and observe maps and charts to demonstrate a problem or solution. They will apply this skill.
Science:	Students will review recycling and the impact of the ozone layer on the earth.
Social Studies:	Students will study the impact of telecommunication on society. They will examine their impression of other cultures through the influence of the media.

Critical Thinking Skills Reinforced

Students will evaluate and understand the impact of the media on society as effected through telecommunication. In groups, they will gather information through research and peer-teach this information through a news presentation. They will evaluate the presentation to gain insight into their own values as influenced by telecommunications.

Teaching Tips

1. Read the Procedure in the student activity sheet.
2. When dividing the class into groups, keep in mind the strengths of the students as they apply to the needs of the group. Each group will need a student who is capable in the language arts area to direct the group in research and script writing. They will need a student who will not be uncomfortable making a presentation before the camera, and students who are able to make any graphics necessary for the presentation. It may take some planning to balance the talents in the groups. You will not assign the roles to the students. Let them decide who will be responsible in each area.
3. Reserve the school library for your day of research. The school librarian can isolate specific materials if given advance notice of the students' topics.
4. Allow only one day for each preparation step. This will keep the class from becoming idle. Work not completed in class can be assigned.
5. Focus not only on the technical part of the activity but also on the content of the presentations as they are designed to cover essential elements. Check the students for understanding.
6. During the evaluation, help the students realize how strongly society is affected by the media, and how the media is not always objective. The questions in the Procedure for the students will help lead them to their own conclusions.
7. The students will need a page of the newspaper to complete their evaluation sheet.

Instructional Strategy

- Open the activity by specifying instructional objectives and outlining the scope of the activity for your students.
- Use the group for cooperative learning and the presentations for peer teaching.
- Conclude the activity with an evaluation of both the technical aspects of communication and the materials presented.

Equipment/Supplies

1. VCR
2. Markers
3. Construction paper
4. Maps
5. Television
6. Map pencils
7. Newspaper
8. Camcorder
9. Glue
10. Magazines
11. Posterboard
12. Paper

Evaluation Key

1. Each student will be graded on his or her notes from the research. This can be a participation grade.
2. The group will be graded on both the written script and the presentation.
3. The group will be graded on the visuals, such as any maps or charts.

4. The film crew will be graded on the quality of the film, their written report, and their presentation to the class.
5. Each student will receive a grade on the evaluation sheet.

Evaluation Sheet Key

1. F
2. H
3. A
4. E
5. B
6. D
7. C
8. G
9. F
10. O
11. O
12. O
13. F
14. O
15., 16. Answers will vary.

Support Materials

1. Tour local television stations, and have guest speakers from local stations.
2. The school librarian will be an excellent resource person.

Modifications for Handicapped, Disadvantaged and LEP Students

Some students may need additional time to research their topic. You may request a helping teacher for the library day.

Name______________________________

News Production Evaluation Sheet

Match the following. Each correct answer earns 5 points.

A. telecommunication
B. network
C. affiliate
D. commercial station
E. satellite communication
F. script
G. format
H. zoom

1.__________ A written text or presentation
2.__________ A quick close-up
3.__________ TV or telephone communication
4.__________ Overseas live broadcast
5.__________ ABC, CBS, NBC
6.__________ Paid and financed by advertising
7.__________ KTBC, KJEJ
8.__________ A plan of organization

Distinguish fact from opinion. Put an "O" next to a news statement that is opinion, and an "F" next to a statement that is fact. Each correct answer earns 5 points.

9.__________ The score was Eagles 10—Lions 9.
10.__________ The Democrats will carry the state in the upcoming election.
11.__________ Most of the refugees looked nervous and confused.
12.__________ Budget constraints and a precarious economy will probably break the company.
13.__________ Because 35,000 square feet of asbestos is currently being removed, officials ran air quality tests to ensure the safety of the students and staff.
14.__________ The law goes a step further than Congress has ever gone in usurping power from the state.

Read the newspaper, and locate one statement of fact and one of opinion. Write the statement, then give your reason for your choices. Each correct answer earns 15 points.

15.____

____

____

____

____

16.____

____

____

NEWS PRODUCTION

Produce a 20- to 30-minute news production that covers a broad range of topics including the weather, sports, and national, state, and local news.

Challenge Statement

A hole in the ozone, instant replay, space exploration, and recycling—all of these issues are covered in magazines, in newspapers, and on the news. Some issues are of serious consequence, while others are simply entertainment, but people need to know the news and are curious about current developments.

Telecommunication is a way of conveying information to the public. This activity will allow you to participate in a simple form of telecommunication.

Objectives

- To understand the technical operation of simple video equipment
- To experience the full scope of a newscast production
- To realize the impact of telecommunication on society
- To learn to recognize the difference between fact and opinion in the news

Vocabulary/Concepts Reinforced

- Telecommunication
- Network
- Affiliate
- Independent station
- Commercial station
- Public station
- Zoom
- Format
- Script
- Close-up
- Medium shot
- Full shot
- Angle shot
- Live broadcast
- Cut
- Freeze frame
- On camera
- Pan
- Tilt
- Voice-over
- Satellite communication

Introduction

Technological developments have change the face of news broadcasting. Fifty years ago all news came over the radio, from movie theaters, or from newspapers or magazines. The news was not always current. Today we can actually watch the news being made around the world through live broadcasts. We call this *telecommunication*, which is communication at a distance.

There are many forms of telecommunication. Television is one of them. This activity will allow you to participate in telecommunication through the making of the news, while learning many of the details that go into a broadcast.

Procedures

1. Review the vocabulary as you observe the operation of a video camera. Pay attention as your teacher demonstrates the techniques from the vocabulary list. Watch the news tonight for content, format, and presentation.
2. Participate in a discussion about how the way people received and relayed news has changed from word of mouth to live satellite broadcasts. How did the printing press change the news? How about the discovery of electricity? How about the computer? What other inventions can you think of that have made changes? Who was responsible for these changes?

3. Your instructor will divide the class into six groups.

   Group 1 This group of only three people will operate the video portion of the newscast. They will be responsible for the lighting and filming of the newscast. They will (1) research the operation of the camera with all the options, (2) write a report, and (3) present its capability to the class after filming.

   Group 2 This group will research and prepare a weather report on the hole in the ozone layer. This will be a five-minute segment on (1) the causes of the breakdown, (2) the effects of the opening, (3) the location, (4) any possible solutions to the problem, and (5) precautions we should take to protect ourselves from harmful rays. The group will show a map of the United States locating the openings in the ozone and any thin areas forming. They will include the map in their broadcast.

   Group 3 This group will prepare a five-minute report on current developments in the U.S. space program. They will (1) include sketches of new technologies in space and (2) predict the future of the space program.

   Group 4 This group will prepare a five-minute debate on the pros and cons of the instant replay as a means of refereeing professional sports. They will (1) explain the technology involved then (2) present their views. They will end the debate by (3) projecting the changes they see in sports as technology advances.

   Group 5 This group will research and report on recycling efforts in their community. They will (1) give statistics about the impact of the continual use of our natural resources, and then (2) outline, in chart form, the resources we can save through recycling. The chart can be graphic or pictorial. They will (3) identify recycling locations in their community and (4) make recommendations about personal recycling efforts.

   Group 6 This group will investigate technological developments in their state. That could involve major industry moving into the state, the use of natural resources, or high tech programs that have provided employment for a large number of people. This students in this group should talk to the instructor or the school librarian for a particular topic. They should (1) identify the topic, (2) describe the topic, (3) report the impact on the state, and (4) describe related developments. They will include a map of the state that will show the major location of interest. The students in the group should find a number of topics and have the instructor approve one for the report.

4. Read your group requirements carefully to be sure you cover all areas. Plan the types of information you will research. Divide the group to be sure all the information will be covered, and prepare to complete your research in one day—tomorrow. You will be graded on the completeness of your work. Everyone in the group will be responsible for researching the topic.
5. After the research is complete, review the material and write an appropriate script for the newscast, covering all areas in the group description. Everyone in the group will help to prepare the script. You have one day to prepare the script.
6. Choose the person or people in your group who will present the broadcast before the camera. They have one day to practice with the film crew. While the presenters practice, other group members will prepare the visual aids, such as maps or drawings.
7. This is film day! The newscasters and film crew will film the production. The remainder of the class will be the audience. Because you will have only one day for filming, everyone must be very quiet and cooperate with the film crew.

8. Watch the broadcast. Listen for the information as you would the evening news at home. Fill in the evaluation sheet. Evaluate the quality of the production.
9. The film crew will give their presentation on the operation of the camera for the entire class. Your instructor or someone in the class can film their presentation.
10. Discuss the answers to these questions. Is the news always accurate? How do we view people of other countries because of the news? Do you think we are given an objective view of their culture? Is the *opinion* of the newscaster ever reported as news? Are important peoples' opinions ever stated as fact? Are societies' attitudes and opinions influenced by the news? Do newscasters ever predict impending crises or problems as fact? How do you think technology will change the broadcasting of the news in the future?

Evaluation

1. Each student must turn in his or her notes from the research.
2. Your group will be graded on both the written script and the presentation.
3. Your group will be graded on the visuals, such as any maps or charts.
4. The film crew will be graded on the quality of the film, the written report, and the presentation to the class.
5. You will receive a grade on your evaluation sheet.

STANDARDS: A COMMON LANGUAGE

Essential Elements: 75.50(b): 1A, 2C, 2D, 3B, 4A, 4B, 5B, 6A, 6D, 7A, 7B, 8A, 8B
75.50(f): 5, 13, 14

TAAS Objectives: Language Arts: RC 1-6; WC 1-4
Mathematics: C 1-5

Activity Overview

Your students will learn to identify the many standards we use every day and understand why they are important. They will participate in activities that demonstrate the use of standards in industry.

Challenge Statement

A car runs a red light and hits you broadside! The driver tells you that you ran the green light! Everyone knows that you go on green and stop on red. That's a standard. The police will back you up. Standards give us guidelines and make our lives easier. What kind of chaos would we have without standards? How many standards do we use every day?

This activity is designed to help your students understand that we benefit by standards. Standards come in the form of measurements, laws, rules, codes, and restrictions. Hopefully, your students will see that these are necessary to keep order, give us a means of communication, and keep us safe. In industry, they save time and money.

Systems Model

Resources
Students as experimenters
Teacher as organizer, moderator, and evaluator
Various materials to perform activities

Processes
Reading and studying information about standards
Brainstorming obvious and obscure standards
Performing experiments
Recording information
Forming deductions

Applications
Technology principles to real world situations
The need for order to standards

Impact
Respect for standards
Career choices
Social order
Understanding of the substructure of industry

Interfacing with Other Disciplines

Language Arts:	Students will learn new concepts, perform activities, and record their results in writing.
Mathematics:	Students will become aware of numbers and measurement as a form of communication.
Science:	Students will see time and temperature as standards.
Social Studies:	Students will understand the benefits of standards to society. The social studies classes could do a compatible unit on laws.

Critical Thinking Skills Reinforced

By participating in various activities, students question, reason, and judge the validity of standards as a benefit in our lives. They will formulate standards to make simple processes easier and more orderly. They will recognize laws and rules as standards to keep order, help us communicate, and save time and money.

Teaching Tips

1. You can use the activities in this unit or design your own with materials that are readily available. To prepare for these activities:
   a. Assemble two sets of twelve nuts and bolts each. In one set, have one bolt slightly larger than the others and one nut slightly smaller. Do not let the size difference be obvious. The students will understand the importance of interchangeable parts from this activity.
   b. Set up a drill press with the bit that will drill a hole to accommodate a dowel peg (a 1/4" bit for a 1/4" peg). Set up two or three other drills with various bit sizes. Be sure to have a vise for hand drills. The students choose the size and equipment they want. Supply each group with a 12" piece of scrap stock. They will understand that setting a standard for size and process will save time and money, and produce a better product.
   c. Drill a hole in four or five scrap boards that would accommodate a standard size marble. Have a bag of ten or twelve marbles to go with each board. Put several similar, but oversize marbles in each bag. Set the board over a container to drop the marbles into. The students will learn about standard sizes and quality control. Emphasize the importance of setting standards at the right stage to avoid mistakes and wasted time and money.
2. Monitor the students as they participate in the activities. Be sure they complete the Activity Worksheet after each activity. Encourage them to discuss the results with their groups.

Instructional Strategy

- Lead the class in an inquiry and discovery discussion and brainstorming session.
- Monitor them as they participate in active experimentation to simulate industrial processes.
- Guide them toward deductions about the usefulness of standards, both personally and socially.

Equipment/Supplies

1. Nuts and bolts
2. Board and dowel pegs
3. Marbles, board, and containers
4. Drills and drill bits
5. Two stopwatches

Support Materials

1. "Industrial Standards," *The Technology Teacher*, May/June 1989.
2. Quality Control and Codes section of textbooks

Evaluation Key

Standards Worksheet Answer Key

1. volume measurement—cup
2. temperature 350°F
3. time 30-35 minutes
4. size
5. money

6.-7. time, money, language

8. This answer will vary. Basically, we would not know when to meet people or show up to school or work, etc.

9-11. This answer will vary. Some answers may be stop signs, traffic lights, yield signs, speed limits, school zones, right of way. Each descriptor will have an explanation.

12-17. Some answers may be clock, school bell, maps, flag, clothes, shoes, door height, electrical plugs and outlets, computers, rulers, calculators, etc.

Modifications for Handicapped, Disadvantaged, and LEP Students

Students with fine motor skills limitations will have difficulty with these activities.

Activity Worksheet

Answer the following questions after you complete your activity.

Nuts and Bolts Activity
How much time did it take each group to complete the process?
Group 1____

Group 2____

Why were the times different? ______________________________

____

How would standardization of parts save time and money?__________________

____

____

____

Dowel Activity
How many dowels fit? __________How many were straight? ________________

What standards could be set to ensure that all the holes were straight and the right size?

____

____

Marble Activity
How many marbles can be used in the marble transport machine? ________________

What happens if one of the defective marbles slips through? __________________

____

How can standards save time and money in this situation? __________________

____

What standards would you set and at what stage?

____

____

____

____

____

Standards Worksheet

Directions: Complete the following questions. Each correct answer earns four points.

Read the following recipe, and list three standards needed to bake this cake.

Pour the cake mix in the bowl.
Add three eggs.
Add 1/3 cup of oil.
Add 1 1/2 cups of water.
Beat 2 minutes with an electric mixer or whisk.
Bake for 30-35 minutes at 350°F.

1.____________________ 2.____________________ 3.____________________

You go shopping and buy a pair of shoes. List two standards you used.

4.____________________ 5.____________________

You go to Mexico on vacation. Name two standards that change that might confuse you.

6.____________________ 7.____________________

8. Describe a situation that could happen if we did not have *time* as a standard.

____

____

____

Identify three driving rules (standards), and tell how they make driving safer.

9.____

____

10.____

____

11.____

____

Look around the classroom, and list six items that act as standards or are regulated by standards.

12.__________________________ 13.__________________________

14.__________________________ 15.__________________________

16.__________________________ 17.__________________________

STANDARDS: A COMMON LANGUAGE

Learn to identify everyday standards, and understand why they are important. Participate in activities that demonstrate the use of standards in industry.

Challenge Statement

A car runs a red light and hits you broadside! The driver tells you that you ran the green light! Everyone knows that you go on green and stop on red. That's a standard. The police will back you up. Standards give us guidelines and make our lives easier. What kind of chaos would we have without standards? How many standards do we use every day?

Objectives

- To realize the many types of standards used in society
- To realize the need for standards as a common language
- To understand the importance of following standards to keep order, stay safe, and be productive

Vocabulary/Concepts Reinforced

- International Standards Organization (ISO)
- Certification of products
- Underwriters Laboratory (UL)

Equipment/Supplies

- Nuts and bolts
- Board and dowel pegs
- Marbles, board, and containers
- Drills and drill bits
- Two stopwatches

Introduction

Standards are so commonplace, we forget they exist. Why do we have them? Picture a society without traffic lights or signs, no way of keeping time, no money exchange, no laws, no measurement, no building rules or restrictions, and no standards for clean water or air. Standards basically provide a common means of communication, guidelines for behavior, and industrial guidelines to make life easier and more productive. If you lived alone on an island, you would not need standards, but living in society with millions of other people requires standards.

Eli Whitney established the use of standards in industry by making standardized parts to assemble 10,000 muskets for a government contract in 1798. Until then, guns were made individually, and each part was custom-made to fit the connecting piece. Because of the large order and time restrictions, no one thought he could fill the order. He surprised everyone with shipping boxes of parts and assembling the muskets on site. This was the beginning of standardized parts and mass production in industry.

This type of standardization saves industry time and money. It allows manufacturers to order from any supplier with the best bid, knowing the parts will work and be properly made with the right materials. The International Standards

Organization (ISO) sets international standards to allow for industry to trade internationally as well as locally. Because of the number of industries and products in this country, over 400 organizations write standards in the United States. Most industries have volumes of written standards that outline nearly everything the company does. With new technology comes new standards.

After a two-year study, a Congressional committee reported that military weapons were being made from substandard nuts, bolts, and screws that caused breaking and shearing under load. They found that the fastener did not meet the materials standards set on the contract, and the defective rate was 58 percent. This costs taxpayers a lot of money and threatens our defense system. This is just one example of the importance of setting and meeting industrial standards.

Safety and performance standards are set to protect consumers. The Underwriters Laboratory is an independent testing organization which certifies products that pass certain quality standards. Look on nearly any electrical appliance or fixture, and you will find the UL certification mark. This mark indicates quality and safety to the consumer.

Standards are set in construction as codes. *Codes* are guidelines that the builder must follow to ensure that the structure is safe for people. Material and structural requirements are important. Inspectors check each stage of construction to guarantee that the codes are being followed. If construction does not meet building codes, it must be corrected.

Another critical area is air and water quality. With the use of hazardous materials in business and industry, restrictions for use and disposal of materials are very important. Improper use can threaten the lives of literally millions through our air and water supply.

Procedure

1. With the class, read the Introduction, and brainstorm all the areas you can where standards are set. Identify the different types of standards.
2. The class will be divided into three groups. Each group will rotate to participate in all three activities.

Activity 1: In this activity you have two sets of twelve disassembled nuts and bolts. Divide your group into two smaller groups. Each group will have the same number of students. Assign two timers. Each group member will sit side by side. The first person assembles the nuts and bolts, the next takes them apart, and the next assembles them, etc.

How much time did it take each group to complete the process? Why were the times different? How would standardization of parts save time and money?

Activity 2: Each student will drill two holes in a board. You can choose your equipment. After all have drilled their holes, assemble the dowels.

How many dowels fit? How many were straight? What standards could be set to ensure that all the holes were the right size and drilled straight?

Activity 3: You are checking parts for a machine that will quickly and efficiently transport marbles though a tube. Misshapen or oversize marbles will jam the machine. Your job is to make sure all the marbles will fit.

Put your set of marbles through the holes. How many marbles can be used in the marble transport machine? What happens if one of the defective marbles slips through? How can standards save time and money in this situation? What standards would you set?

3. Complete the Activity Worksheet as you complete each activity. Discuss the results among all the groups.
4. Complete the Standards Worksheet after you complete all the activities and the Activity Worksheet.

Evaluation

You will receive a grade for your Activity Worksheet and your Standards Worksheet.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 8
(1-2 DAYS)

ENERGY STATES

Essential Elements: 75.50(b): 1A
75.50(f): 8, 9
TAAS Objectives: Language Arts: RC 1, 4, 5

Activity Overview

The instructor will demonstrate a variety of examples of potential energy and kinetic energy. During the demonstration, students will complete the worksheet. After the demonstration, students will work in a group to list examples of potential energy and kinetic energy. The lists may be subdivided into three headings: mechanical, chemical, and gravitational. After the groups have made their lists, each group will report to the class. A combined list will be recorded, word-processed, duplicated, and given to class members.

Challenge Statement

Energy conversion and use is an important part of our daily lives. Nature provides many examples of energy conversion, including the "food chain," the ability of moving water to do work, or a lightning bolt (electricity) starting a forest fire and releasing chemical energy as light and heat. If we are to convert and use energy efficiently, we must understand the process and the laws that govern it.

Systems Model

Resources
Students as observers and information gatherers
Teacher as demonstration technician and moderator
Materials and equipment to demonstrate potential and kenetic energy

Processes
Potential and kinetic energy experiments
Brainstorming
Information gathering
Observation

Applications
Observation to information gathering
Knowledge of potential and kinetic energy to real-life energy supplies

Impact
Environmental concerns
Society's use of energy
Understanding science concepts

Interfacing with Other Disciplines

Science: Photosynthesis, food chains, forms of energy, states of matter
Language Arts: Context, sentence structure

Social Studies: Group techniques: brainstorming, etc., comparison of societies in which engines and energy conversion devices are common with more primitive societies (e.g., the role of energy conversion devices in the Industrial Revolution)

Critical Thinking Skills Reinforced

Comprehension: understanding relationship between and differences in potential energy and kinetic energy, giving examples of both

Analysis: determining categorization for energy examples on lists

Teaching Tips

1. Use a "script" to practice or guide the demonstration. Be sure to clearly explain the various forms of kinetic and potential energy to enable students to determine the correct terms for the worksheet.
2. Explain the use of context in helping to identify correct terms. To check understanding, have students read the sentences and paragraphs after completing the worksheet.
3. Transparencies of various energy forms are useful, but some demonstrations with physical objects are preferable. After the demonstration, it may be helpful to allow students to experiment with or use the devices demonstrated.
4. Group size of four to six is desirable (preferably no fewer than three and no more than seven). Teacher should explain clearly and emphasize the rules or guidelines for group activities. For example, while criticism or correction is not allowed in brainstorming, it is useful in evaluating or organizing the list afterwards. However, comments must be positive, constructive, and about the material rather than negative or directed at the person who contributed the item.

Instructional Strategy

- Read the objectives and vocabulary terms/concepts to the students prior to the start of the demonstration. You may also want to read at least part of the worksheet aloud so that students "hear" the organization and thought pattern of the material they are completing.
- If groups have not used group techniques previously, they may need guidance from the instructor. Primary areas of emphasis should be on the "free flow" of ideas during brainstorming, without criticism or critique. The evaluation of ideas is allowed only when the group is refining the list for group presentation or preparation of the class list.
- For more advanced students, a discussion of the inefficiency of energy transfer could be included. Items such as light bulbs, which are designed primarily to produce light, actually use a large percentage of the input energy to product heat. Many energy conversion processes produce waste heat, including the human body, engines, and some chemical reactions.

Equipment/Supplies

1. Model of a dam and waterwheel (or a model waterwheel and cup of water to pour over it)
2. Candle and/or alcohol burner
3. Flashlight with battery
4. Toy car with "friction" type motor
5. Mousetrap and/or rubber band
6. Teakettle with "pinwheel" to turn in the discharged steam
7. Ramp with two balls of similar size, but different weights, and two blocks of wood (about the same size and weight, to be placed at bottom of ramp and hit by balls rolling down ramp)

Evaluation Key

Individual: Turn in and score worksheet answers.

Group: Points awarded on a comparative scale for both quality and quantity of list items produced. (For example, 1st place = 100, 2nd place = 94, 3rd place = 88, etc.)

Worksheet Answer Key

1. kinetic
2. potential
3. kinetic
4. gravity
5. kinetic
6. kinetic
7. heat
8. light
9. electricity
10. light
11. mechanical
12. kinetic
13. velocity
14. momentum
15. more

Support Materials

1. Bohn, R.C., and MacDonald, A.J. *Power: Mechanics of Energy Control.* 2nd ed. Bloomington, Ill.: McKnight, 1983.
2. Stephenson, G.E. *Power Technology*. Albany, N.Y.: Delmar, 1979.
3. Walker, J.R. *Exploring Power Technology*. South Holland, Ill.: Goodheart-Willcox, 1976.

Modifications for Handicapped, Disadvantaged, and LEP Students

Students with limited reading skills or English proficiency may need assistance in completing the worksheet.

Name ______________________________

Worksheet

Energy is either in use or stored. If it is stored, we call it **potential energy**. If it is being used or doing work, we call it **kinetic energy**. Potential energy is not useful as it is, but must be changed somehow into kinetic energy. Work, then, is done using (1) ____________ energy.

Both potential and kinetic energy can be found as **mechanical energy, chemical energy, or gravitational energy.** The water held behind a dam is a type of (2) __________ energy. As the water is released to turn a waterwheel or turbine, it becomes (3) ____________ energy. The stored energy becomes kinetic energy due to the force of (4) __________________.

Energy can also be stored in chemical form. For example, a fuel stores energy to be released by burning. As the fuel burns, the potential energy becomes (5) ________________ energy, which may be used as heat, light, or motion (force). A candle is an example of potential chemical energy from fuel being changed into (6) _____________ energy, which is given off as (7) ____________ and (8) ____________. In a flashlight, for example, the energy in the dry cells is released as (9) ______________, which is used to create (10) _________________________ from the bulb.

Sometimes it is desirable to store energy in a mechanical form. A toy car with a "friction type" motor illustrates this principle. Inside the motor is a flywheel, which is a heavy device capable of storing the energy put into it as you push the car on the floor. This potential (11) _____________ energy is then released as (12) __________________ mechanical energy to move the car across the floor. Once the flywheel is moving, it will continue to move in the same direction until some other force, such as friction, slows it down or stops it. The tendency to keep moving is called the inertia of the flywheel. All objects have inertia. The inertia of an object in motion tends to keep it in motion at the same speed and in the same direction. If an object is at rest, its inertia tends to keep it at rest unless a force causes it to move. The **mass** of an object is a measure of the inertia of the object. The term *mass* is sometimes used to refer to the weight of an object; although there is a scientific difference in mass and weight, it may be helpful to think of mass as similar to weight. The heavier the object, the more energy it can store.

An object in motion has **momentum**. The momentum depends upon two factors: its **mass** and its **velocity**. Velocity refers to the speed at which the object is moving. The faster the object is moving, the more (13) ______________________ it has. The momentum of an object is the product of an object's mass (or weight) times its velocity (or speed), written mathematically as $M = mv$. A heavy object has more (14) ____________________ than a lighter object if they are both moving at the same speed. For example, a 2,000 kg car moving 90 km/hr has twice as much momentum as a 1,000 kg car moving 90 km/hr at the same speed. Since the momentum of the heavier car is greater, it will take (15) ______________________ force to stop the heavier car.

ENERGY STATES

Observe demonstrations to see the ways in which energy is stored and released, and give examples of potential energy and kinetic energy.

Challenge Statement

Energy conversion and use is an important part of our daily lives. Nature provides many examples of energy conversion, including the "food chain," the ability of moving water to do work, or a lightning bolt (electricity) starting a forest fire and releasing chemical energy as light and heat. If we are to convert and use energy efficiently, we must understand the process and the laws that govern it.

Objectives

- To know and be able to use correct vocabulary terms to describe types of energy
- To state examples of potential and kinetic energy in different forms
- To give examples of energy forms and classify them according to whether they are potential or kinetic energy
- To work with group members in a positive, effective manner to carry out the assigned project

Vocabulary/Concepts Reinforced

- Energy states
- Potential energy
- Kinetic energy
- Mechanical energy
- Chemical energy
- Gravitational energy
- Inertia
- Momentum
- Mass
- Velocity

Equipment/Supplies

- Pencil or pen to complete the worksheet
- Chalkboard or easel/pad to record group lists

Introduction

Your instructor will demonstrate a variety of examples of potential energy and kinetic energy. You should be able to think of many other examples after seeing the demonstration. Following the demonstration, you will "brainstorm" in a group to help you think of other examples. Brainstorming is used to help people think creatively.

Procedure

1. Read over the worksheet to see what type of information you need to gather during the demonstration.
2. Watch and listen carefully to the demonstration. Fill in the blanks with the correct terms during the demonstration.
3. After the demonstration, brainstorm with your group to list examples of potential energy and kinetic energy.

   a. Select a chairperson and a recorder. If possible, record the responses on a chalkboard or a large tablet so that all members can see the list being made.
   b. Go around the group (in clockwise or counterclockwise order). Each member should state an example of potential energy or kinetic energy and tell which subcategory is correct for the item.
   c. Do not allow any criticism or negative comments to be made during the brainstorming session. Go around several times or until members have no more examples.
4. As a group, use good committee meeting techniques to organize the lists into a group report. You may need to combine similar examples, move examples which should be in other categories, etc., but be sure that all group members are able to discuss and understand the items on the list.
5. Select a member to report to the class. After each group has reported, help your classmates to combine the group lists into one list.
6. Review the list of vocabulary terms and the objectives for this activity. Be sure that you understand and can correctly use the terms to describe potential and kinetic energy.

Evaluation

Your worksheet will be graded. Also, points will be awarded to the teams according to how many examples your group lists and whether you correctly list examples in the categories given.

(1-2 DAYS)

CHEMICAL ENERGY

Essential Elements:	75.50(b): 1C, 4A, 4B, 6A, 6B, 6D 75.50(f): 8, 9, 10
TAAS Objectives:	Language Arts: RC 1, 4, 5; WC 6 Mathematics: C 4

Activity Overview

This activity introduces students to the use of chemical energy to produce electrical energy. After completing a written assignment on primary and secondary cells, they will construct cells and demonstrate chemical reactions producing electricity.

Challenge Statement

One of the basic methods of obtaining electrical energy is from chemical energy. The object that does this today is the battery. We use batteries every day in flashlights, hearing aids, cameras, automobiles, and many other devices. Understanding how batteries work helps us to use and care for them properly.

Systems Model

Resources
Elements and compounds such as copper, zinc, magnesium, carbon, nickel, cadmium, lead, and ammonium chloride

Processes
Chemical reactions

Applications
Dry cells, wet cells, batteries

Impact
Environmental: availability of chemical elements, disposal of used cell
Social: portable energy sources

Interfacing with Other Disciplines

Mathematics:	Measurements (linear, volume, weight), reading dials and gauges
Science:	Reduction/oxidation (redox) reactions
Social Studies:	Possible topics for research and study include the lives and contributions of Michael Faraday, Luigi Galvani, and Alessandro Volta.

Critical Thinking Skills Reinforced

Comprehension:	Comparison and interpretation of results
Application:	Math principles applied to predict outcomes of related situations

Teaching Tips

1. SAFETY CAUTION: This activity requires that students be instructed with regard to the safe use of chemicals, proper safety glasses, and clothing. An area should be provided to prevent spilled chemicals from spreading uncontrolled. A large flat tray or sink would be useful.

2. If time allows, students may use all combinations of three strips with at least the first solutions in order to compare the effects of electrode composition as well as of various electrolytes.
3. Since many technology teachers do not have extensive experience with "chemistry" experiments, it is recommended that the teacher perform the experiment (including all combinations) before assigning the activity. This will allow the teacher to obtain results for the variations possible in the activity and anticipate student questions.
4. The students can be divided into groups, with selected electrode combinations assigned to the groups (three different combinations). After the activity, each group can report their results to the class for discussion and comparison of results.
5. Stress to the students the importance of measuring carefully, following instructions, and recording results accurately. Some may need instruction on reading the dials and scales on the voltmeter used. Since the cells produce relatively small voltages, the values need to be carefully determined and recorded in order for comparisons to be valid.
6. For materials that are not available in the technology lab, the science teacher (or high school chemistry teacher) may be able to provide assistance.
7. The teacher may wish to mix the copper sulfate and ammonium chloride solutions in quantities sufficient for all the groups and provide for each individual or group the amount needed for the activity.

Instructional Strategy

- The activity can be performed in small groups, with each student reading the voltmeter and recording results individually. As an alternative (or if adequate equipment is not available), the activity could be performed as a demonstration, with each student observing and recording results. When working in groups, it is important that each student actively participate in the activity, observe, and record results.
- Be sure that each student clearly understands the procedure to be followed and has all needed supplies collected before beginning the activity.
- The use of transparencies or other visual aids to explain the basic process of producing electricity from chemical reactions will be helpful in explaining an "invisible" process to the students. Suggested diagrams include an illustration of the test tube and electrode setup with arrows indicating electron movement and a cutaway view of a common dry cell or automotive battery (with electrodes, electrolyte, etc., labeled). Point out to the students that the key parts are the same, but the physical arrangement varies with the application. (Most chemistry texts have a description of the redox process with good illustrations.)

Equipment/Supplies

1. One 1 cm x 8 cm copper strip
2. One 1 cm x 8 cm zinc strip
3. One 0.2 cm x 8 cm magnesium rod
4. One voltmeter
5. 10 grams copper sulfate
6. 25 grams ammonium chloride
7. One 1-lb coffee can full of sand
8. One small test tube
9. One 500 ml Pyrex tumbler
10. Two test leads
11. 355 ml Coke
12. 355 ml Diet Coke
13. 355 ml 7-Up
14. 2 AA dry cells (C or D size will also work)

Evaluation Key

Students should complete the written exercise before performing the lab activity. The results of the lab activity should be recorded on the form provided. Both parts should be turned in at the same time and graded. Answers for the written exercise and typical results from the lab activity are given below.

1. Answers will vary (radios, flashlights, etc.)
2. Answers will vary (lanterns, etc.)
3. Answers will vary (radios, remote control cars, etc.)
4. automobile, tractors, boats, etc.
5-7. electrodes, electrolyte, container
8. primary or dry cell (some may say "rechargeable" if that is what they use at home!)
9. 1.5 (volts)
10. automobile
11. primary
12. secondary
13. The battery must be able to be recharged and discharged repeatedly as electricity from the wind machine (generator) is produced, stored, and used.
14-18. depends on experiment
19. sulfate solution
20. Diet Coke
21. Coke
22. 1.5 volts each (if fully charged)
23. the sum of the answers in no. 22
24. 12 volts

Support Materials

Bohn, R.C., and MacDonald, A.J. *Power: Mechanics of Energy Control.* 2nd ed. Bloomington, Ill.: McKnight, 1983.

Modifications for Handicapped, Disadvantaged, and LEP Students

The "buddy system" will be helpful to students who have inadequate reading, writing, or math skills to comprehend the instructions and record results and answers. It will also be helpful to those students with limited physical skills who have difficulty handling the materials.

CHEMICAL ENERGY

Construct cells using a variety of materials, and compare the amount of electricity produced by the different cells.

Challenge Statement

One of the basic methods of obtaining electrical energy is from chemical energy. The object that does this today is the battery. One main advantage of the battery is that it is portable. Unlike the electricity in your home (which requires a system of wires connected to wires from the electric utility), a battery contains all the materials needed to produce electricity in other locations. We use batteries every day in flashlights, cameras, automobiles, tape and CD players, and many other devices. A main disadvantage of batteries is that the electricity they produce is limited by the amount of chemicals in the battery. Using batteries correctly and taking care of them is important if we expect them to have their energy available when we need it. Understanding the way they work helps us use and take care of them properly.

Objectives

- To learn about primary and secondary cells
- To build cells using a variety of materials
- To learn how to use a voltmeter to measure electrical voltage
- To learn and practice safe methods of working with chemicals
- To learn how batteries are made by combining cells

Vocabulary/Concepts Reinforced

- Cell positive
- Battery negative
- Electricity acid
- Primary cell
- Electrons
- Secondary cell
- Terminals electrode
- Electrolyte
- Rechargeable
- Voltage
- Voltmeter
- Circuit
- Electrochemical

Equipment/Supplies

- One 1 cm x 8 cm copper strip
- One 1 cm x 8 cm zinc strip
- One 0.2 cm x 8 cm magnesium rod
- One voltmeter
- 10 grams copper sulfate
- 25 grams ammonium chloride
- One 1-lb. coffee can full of sand
- One small test tube
- One 500 ml Pyrex tumbler
- Two test leads
- 355 ml Coke
- 355 ml Diet Coke
- 355 ml 7-Up
- 2 AA cells (C or D size may be used)

Introduction

This activity includes two parts. The first part is a written exercise to help you learn about two types of cells: primary and secondary. The second part of the experiment includes building cells from a variety of materials and comparing the results to see which combinations produce the most electricity. (You should finish the written exercise before beginning the lab work.) This activity requires that you work very carefully and safely with a variety of chemicals. Read the instructions carefully and follow safety rules. These safety rules include wearing safety glasses to prevent chemicals from splashing in your eyes and wearing appropriate clothing.

Procedure

Written Exercise

Cells and batteries are used by almost everyone each day. Very likely, in your home or at school, there are dry cells or dry batteries being used in flashlights, radios, cameras, and other items. The first electrochemical cell was invented by Alessandro Volta, an Italian physicist (1745-1827). The batteries and cells we use today operate on the same principles as the first cell, but have been modified and improved over the years by technologists and scientists. Figure 1 illustrates some of the types of cells and batteries that are used now.

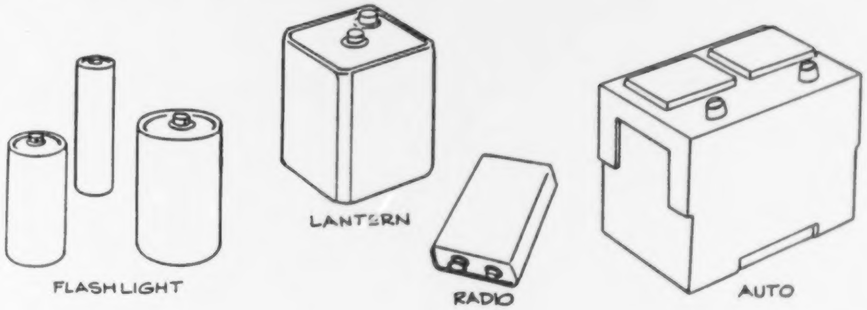


Fig. 1.

For each of the types illustrated above, list items that would use that type of cell or battery.

(1)____

(2)____

(3)____

(4)____

There are two types of electric cells, called primary and secondary cells. Both produce electricity (the movement or flow of electrons in a conductor) by chemical action. A battery is made up of more than one cell connected into a single unit.

1. Primary cells cannot be recharged after the active ingredients have been consumed from an external use of the battery cell. A battery charger will not reverse the process of discharging of electricity to restore the cell back to its original state of charge (see fig. 2).

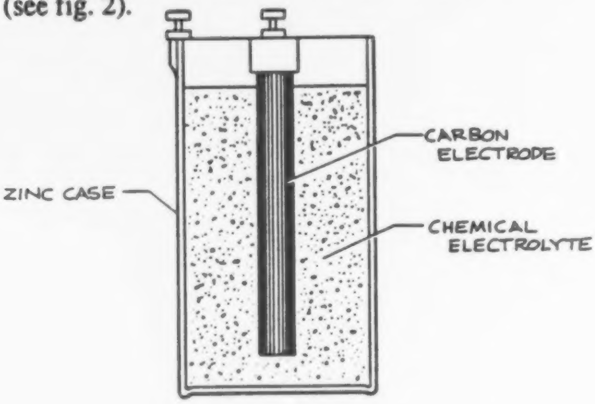


Fig. 2.

A primary electrical cell consists of two plates or rods called electrodes, a chemical called an electrolyte, and a container. The most common type has one electrode of carbon which is also called a positive post. The negative electrode is made of zinc and is often also the container. The electrolyte is the chemical between the electrodes. A voltaic cell in which the electrolyte is a thick, moist paste is called a dry cell. List the three basic parts of an electric cell: (5)____________ (6)____________ (7)____________

2. A secondary cell is rechargeable (can be recharged) after the active ingredients have been consumed. It may be restored to its original condition by using a battery charger. The reaction of the chemicals on discharge may be reversed by an outside voltage source once they have been depleted (see fig. 3).

In a wet cell, which is a common type of secondary cell, the positive electrode or plate is made of lead while the negative electrode consists of lead peroxide. The electrolyte, or chemical, which surrounds the plate is a diluted acid mixture. The two electrodes or plates are separated from each other by a porous material. These materials are made from wood, spun glass, or a rubberized material. The voltage produced is determined by the acid strength and the conditions of the plates. The current produced will be controlled by the number and size of the plates. A secondary cell is fully charged when the two terminals are filled or surrounded by electrons, which stops the acid from reacting with the plates. However, when the terminals are connected to an outside path or circuit, the electrons on the terminal begin to move from the negative to the positive terminals (see fig. 4).

8. The most common type of cell used in small electrical devices in the home is the ________________________.
9. The voltage typically produced by this type of cell is__________ volts.
10. The most common use of a secondary cell is in the family__________.
11. The battery which cannot be recharged is the__________ battery.
12. Which type of battery would be used to store electricity from a wind machine?
____
13. Explain why that type of cell would be needed.
____
____

Lab Activity

1. Mix 10 grams of copper sulfate and distilled water in a 500 ml Pyrex tumbler. (Heat)
2. Partially bury the test tube in a can of sand to hold it. Slide a piece of cardboard into the test tube as a divider.
3. Fill the test tube 3/4 full with copper sulfate solution.
4. Mix 25 grams ammonium chloride with 500 ml of H_2O. (No heat)
5. Clip the test leads onto any two of the metal strips. Connect the other end of the leads to the voltmeter. Record the voltage reading on line 14 of the chart provided (in the column for the two electrode you used).
6. Slide the two strips into the test tube on opposite sides of the divider (fig. 5).
7. Add ammonium chloride solution to the test tube. (Do not overfill.)
8. Leave the strips in the solution for 2 minutes for any test (fig. 6). Record the voltage reading on line 15 of the chart.
9. Remove the strips and cardboard divider. Dry and clean these items first, then pour out the copper sulfate solution, and rinse the test tube.
10. Insert a new cardboard divider into the test tube. Fill the tube 3/4 full of Coca-Cola. Once again, place the metal strips in the test tube, two at a time. Record the voltages on line 16 of the chart.
11. Repeat steps 9-10, using 7-Up in the test tube. Record the voltages on line 17.

12. Repeat steps 9-10, using 7-Up in the test tube. Record the voltages on line 18.
13. Answer the questions on the report sheet.

Evaluation
Your work on the written exercise and the report sheet will be graded.

SOLUTION	ZINC & COPPER	ZINC & MAGNESIUM	COPPER & MAGNESIUM
14.			
15.			
16. COCA-COLA			
17. DIET COKE			
18. 7-UP			

Questions

19. Which combination of strips and solution worked best? ________________
20. Which solution produced the least electricity? ________________
21. Which solution produced the most electricity? ________________
22. Using the voltmeter set to measure voltages in the range of 0 to 5 volts, determine and record the voltage of each of the cells provided. ____________ ______________
23. Place the two cells end to end (positive terminal on one to negative terminal on the other). Using the voltmeter, determine the voltage of the two cells together. The voltmeter leads should be placed at the ends of the two-cell unit. Record the voltage. ____________________
24. If each cell of an automobile battery is capable of producing 2 volts, what would be the total voltage available from a battery made of 6 cells? _________

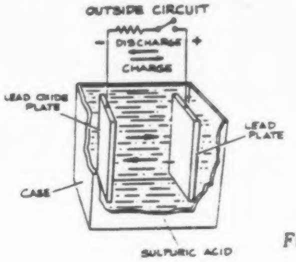

OUTSIDE CIRCUIT
-
DISCHARGE
+
CHARGE
LEAD OXIDE PLATE
LEAD PLATE
CASE
SULFURIC ACID

Fig. 3.

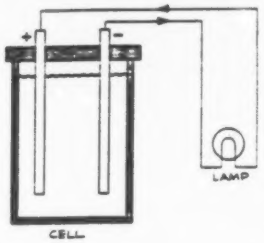


Fig. 4.

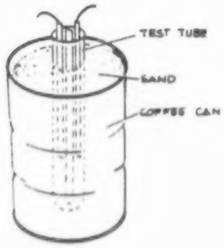

TEST TUBE
SAND
COFFEE CAN

Fig. 5.

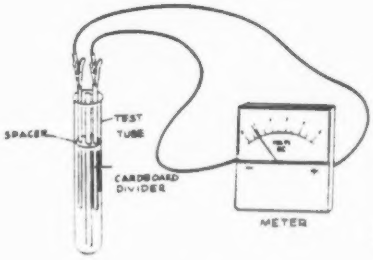

SPACER
TEST TUBE
CARDBOARD DIVIDER
-
+
METER

Fig. 6.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 10
(1 WEEK)

ENERGY CONSERVATION

Essential Elements:	75.50(b): 1C, 3A, 4A, 4B, 6C, 6D, 7B, 8B 75.50(f): 8-11
TAAS Objectives:	Language Arts: RC 1, 4, 6; WC 1-4 Mathematical: C 2, 4; O 3, 4; PS 2-4

Activity Overview

In this activity, the student will evaluate energy usage of various household appliances and work with units of measurement in energy and power. Also included are sheets describing an Energy Conservation Contest and a Resource Conservation Contest. The contests (one or both) may be used as a class, schoolwide, or districtwide competition.

Challenge Statement

"Energy conservation" is a common phrase today. It is important that students understand energy units, typical energy consumption of various devices, areas of energy waste, and the limited availability of some types of energy. In order to be informed and wise consumers, students must have accurate information about energy use and practice in making decisions about efficient use of energy.

Systems Model

Resources

Electrical energy processes; conversion of electricity to heat, mechanical energy, light, and other forms by appliances

Processes

Research and study of principles and laws of electricity
Experiment with the flow of electricity
Measuring the flow of electricity
Recording and analyzing information

Applications

Appliances and laborsaving devices such as refrigerators, lights, popcorn poppers, hair dryers, toasters, coffeemakers, mixers, etc.

Impact

Social:	Increase in standard of living, need for manufacturing plants and workers to produce appliances
Environmental:	Use of raw materials for products, use of various fuels to produce electricity, disposal of wastes from energy conversion process, limited traditional fuels, need for conservation of energy, waste heat from conversion processes

Interfacing with Other Disciplines

Mathematics:	Fractions, multiplication and division, units
Science:	Electricity, Ohm's law, energy conversion, fuel use, and depletion
Language Arts:	Vocabulary development and context clues, organization and presentation of a report or composition

Social Studies: Development of machines and devices to improve standard of living, inventors, opposing viewpoints between environmentalists and consumer/industry groups on energy conservation. (*Note:* An interesting topic of study might be energysaving devices and fuels which have been invented, but not been marketed for a variety of reasons [political or other!]. As an example, *Mother Earth News* in the 1980s featured an article about a man who cooked his eggs by placing them in a compost pile and using the heat generated by the compost!)

Critical Thinking Skills Reinforced

Comprehension: Use of root words in related vocabulary terms

Application: Solving problems involving electrical units and mathematical processes, application of principles of energy conversion to design of a conservation project

Synthesis: Combining knowledge about energy conversion, materials and processes, and energy sources into a project involving new energy sources or conservation of existing sources

Evaluation: Developing own opinions about waste and conservation, judging existing products and policies

Teaching Tips

1. Watt-meters may be available from the local utility company for loan to schools.
2. Students may have difficulty initially with units of energy and power, and with understanding the relationship between energy and power. Provide several examples in the classroom of mathematical calculations similar to those required in the activity.
3. Check with the local utility company to see if a guest speaker is available from their customer information department to explain about the services they provide to the community. Information provided can include numerical values such as the total output of the utility company's system and the usages typical of the community, the type of fuel used to produce electricity, the type of jobs found in a utility company, ways to conserve energy, and possibly pamphlets which can be distributed to students on various energy-related topics.
4. Emphasize strongly that safety is critical when working with electricity at the voltages and amperages typically found in home appliances. Demonstrate correct usage of the watt-meter as well as general safety rules for working around electricity.
5. A Competition Coordinator should be selected to direct the competition (probably the teacher at one school if the contest is open to different schools). Also needed are judges and members of an Accounting Committee to verify point totals and assign 1st, 2nd, and 3rd place winners. If the competition is open to other schools, the contest announcement should be mailed out well in advance to allow time for project construction and to get an indication of the number of projects to expect. Entry forms may also be distributed with the announcement so that they can be completed before bringing in the project. Rating sheets for judges should be ready for distribution by the contest date. Levels should be determined in advance and might be classifications such as grade level or first/second year technology students, etc. For a competition within one school and for students enrolled in the same course, one level may be sufficient.

Instructional Strategy

- It will be helpful for some students to have materials (journal, magazine, or newspaper articles, etc.) available to become familiar with current concerns about energy conservation. For some, this may tend to stifle their creativity and result in a project modeled after some they have seen.
- A discussion of the various types of energy sources now used may be needed to help students decide on a project topic that will be of interest to them. This may also help to diversify the topics chosen in a class.

- If possible, students should be encouraged to construct models (perhaps working!) and test their project for self-evaluation. In other cases, students should be encouraged to use known laws, math, etc., to predict whether their project would work as designed.
- The competition aspect may be used as a motivational tool by awarding appropriate prizes in the class, school, or intraschool competition. However, this should not overshadow the intent to honor and recognize all students who participate.
- Strongly encourage the project to be well written, constructed, and displayed. If possible, the projects may be displayed for the school and/or community to view. A source of judges might be the local utility company community service department personnel.

Equipment/Supplies

1. Wattmeter
2. Popcorn popper
3. Toaster
4. Hair dryer or blow dryer
5. Ribbons for contest participants
6. Trophies (3) for contest winners
7. Lamp with light bulb

Evaluation Key

Typical values for energy use of appliances is provided in a table. Also, the instructor should be aware of the manufacturer's ratings for the appliances used (typically found on a plate with the serial number, etc.) When checking the work, look for correct steps and procedures rather than just numerical answers. Students should write and show work involving units as well as numerical values.

Answers to questions:
(1) large diameter wire
(2) wattage
(3) amperage
(4) voltage
(5) 5 ohms
(6) 2 amp
(7) 220 volts
(8) 96 watts
(9) 80 watts

Support Materials

Priest, Joseph. *Energy: Principles, Problems, Alternatives*. 3rd ed. Reading, Mass: Addison-Wesley, 1984.

Modifications for Handicapped, Disadvantaged, and LEP Students

Small groups may be useful, with groups containing students of different ability levels. Group members should be responsible for monitoring safety rule compliance of other students. Calculations and comparison of student results with manufacturer ratings may be difficult for students with limited mathematical skills. Teacher or peer assistance may be needed.

ENERGY CONSERVATION

Learn about energy use and conservation by finding out how much electrical energy various appliances use, and developing a project about energy conservation and/or resource conservation.

Challenge Statement

Many devices in our homes use electricity. You may have experienced a loss of electrical power in your home when a thunderstorm disrupted the electrical supply from the utility company or when you tried to use too many appliances on the same circuit at one time. In order to be a wise consumer of energy, you must know about energy and how it is measured, how it is used by devices, why conservation is important, and how to reduce the amount of energy you use.

Objectives

- To know and be able to use correctly vocabulary and terms related to energy use
- To know how to safely and correctly use a wattmeter
- To be able to calculate voltage, amperage, or power when given the appropriate numerical values for other variables
- To be able to describe and use ways to conserve energy

Vocabulary/Concepts Reinforced

- Electricity
- Electrons
- Current
- Circuit
- Conductor
- Insulator
- Amperage
- Voltage
- Watt
- Energy
- Power
- Resistance
- Ohm
- Ohm's law conservation

Equipment/Supplies

- Wattmeter
- Popcorn popper
- Toaster
- Hair dryer or blow dryer
- Lamp with light bulb

Introduction

In this activity, you will be using a wattmeter to measure the amount of electrical energy used by various home appliances. It is important that you know how to use the wattmeter correctly and follow safety rules carefully. The electrical amperage and voltage present in household electrical use can be dangerous if you come in contact with it. It is also important that you read the wattmeter correctly, record data accurately, and be able to use the obtained values in mathematical calculations as instructed. You should also be thinking about ways to conserve energy by either reducing the amount of energy you use or finding new sources of energy. Conservation is important since many of the fuels used today to produce electricity are in limited supply.

Procedure

Appliance Use Activity

Read the paragraphs that follow, and answer the questions.

Electricity is the flow of electrons (or current) through a conductor. Remember (or review) that atoms contain a nucleus (containing neutrons and protons) which is surrounded by electrons in "orbits" around the nucleus. Electrons have a negative charge, protons have a positive charge, and neutrons have no charge.

A complete circuit is required for electricity to flow. A circuit is the path of the electric current (electrons) from the source to the place it is needed and back to the source.

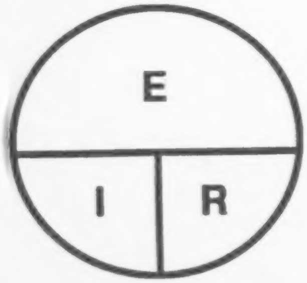
Since electricity is defined as the flow of electrons, it must flow from an area that has many electrons (negative) to an area that has fewer (positive). The term *amperage* (symbolized by *I*) refers to the rate at which electricity is flowing through the conductor. *Voltage* (symbolized by *V* or *E*) is the "pressure" pushing the current through the circuit, while *resistance* (symbolized by *R*) is the opposition to the flow of electrons by the circuits. Resistance is measured in units called *ohms*. Amperage is measured in units called *amperes* (or amp), and voltage is measured in *volts*. The rate at which energy is converted is called *power* and is measured in units called *watts*.

It may be helpful to think of electrical flow as similar to the flow of water through a hose. Pressure in the system causes the water to flow when the valve is opened (similar to voltage in an electrical system). Amperage can be compared to the rate of water flowing through the hose. Resistance can be thought of as restrictions in flow, such as a small diameter opening or a twist or knot in the hose. Wattage can be compared to the amount of water coming out of the hose. Another way to describe the flow of electricity is to say that the voltage tries to force electrons to move and overcome resistance, with the resulting flow measured in amperes. (1) If an electrical conductor can be compared to a water pipe or hose, which conductor (a large diameter wire or a small diameter wire) should be able to carry more electricity or have less resistance? ____________ Many times, one measuring device can measure voltage, amperage, and resistance and is called a *multimeter*. For each measuring device listed, write the correct word to indicate the characteristic of electricity that it would measure. Look at the root words to help you decide.

(2) wattmeter ____________________ (3) ammeter ______________________

(4) voltmeter ____________________

Two laws are used in predicting the results in an electrical circuit. One is called Ohm's law and is named after the German physicist who discovered it. It is generally expressed as $E = I \times R$, or voltage = amperage × resistance. If any of the two values are known, the third can be found using mathematics. Ohm's law is also commonly written as the symbol shown below.



The symbol can be used to help remember the relationship between the values.

If E is unknown, cover it with a finger and the formula becomes:
I x R

If I is covered with a finger, the formula reads

$$\frac{E}{R}$$

If R is covered with a finger, the formula is:

$$\frac{E}{I}$$

The other law commonly used expresses the relationship between voltage, amperage, and power (wattage). It is written as $P = I \times E$, or power = amperage × voltage.

For each set of values given, calculate and record the missing value. Be sure to include the units in your answer. Remember to show your work.

(5) E = 10 volts, I = 2 amp R = ____________________
(6) E = 120 volts, R = 60 ohms I = ____________________
(7) I = 2.2 amp, R = 100 ohms E = ____________________
(8) E = 12 volts, I = 8 amp W = ____________________
(9) I = 2 amp, R = 20 ohms W = ____________________

(*Note:* This calculation requires two steps. Since the formula for W requires the values for I and E, you must first find E from the information given.)

Electrical energy is provided to our homes and businesses by the utility company. They use fuel to produce steam, which drives generators to produce electricity. This electricity is distributed over a network of transmission lines. Because many of the fuels used are limited, it is important that we discover other energy sources and ways to conserve the energy sources we use now.

Electricity flows more easily through some materials than it does through others. The materials that allow electricity to flow easily are called *conductors*, and include metals, water, and our own bodies. Materials that do not allow electricity to flow well are called *insulators*, and include wood, glass, and most plastics. You have probably seen wires designed for carrying electricity in homes, which have a core of copper or aluminum wire surrounded by a plastic coating. The coating (an insulator) is designed to protect you if you accidentally touch a wire carrying a current or to prevent wires which touch each other from creating a "short circuit." Remember that even though a wire is covered by a protective coating, it can still be dangerous. The wires that carry electricity to your home have a covering, but have enough voltage and amperage that you can be killed if you touch them or hit them with a pole or other conductor!

2. For each appliance listed in the chart, connect the appliance to the wattmeter as demonstrated by your instructor. Be sure to follow safety rules carefully. Read the wattmeter correctly, and record the amount of energy used on the chart.
3. After recording the data from your experiment, fill in the other information requested. You will need to do some mathematical calculations to obtain the missing values. Use the appropriate formula, and show your work (steps) in the correct order.
4. Next, look at the information panel on the appliance. This panel contains information about the appliance's energy use which has been provided by the manufacturer. Write the information you find in the correct spaces in the chart.
5. Compare the data you calculated with the data provided by the manufacturer.

Energy Conservation or Resource Conservation Project

1. Carefully read the student project sheet. You will either be working individually or in groups as directed by your teacher.
2. Follow the instructions on the sheet to complete a project describing a way to conserve energy.
3. Your teacher will provide information on the contest date and times. Be sure to do your best on the project. Be careful to describe your project or process clearly and neatly!

Evaluation

Turn in the sheet with the results of your appliance testing. Your project will also be graded.

Electric Appliances

Electric Product	*Typical Watts*
Air conditioner (central):	
3 ton	4500
5 ton	7500
Room:	
Bedroom	900
Living room	1200
Multiple rooms	1500
Blender	385
Can opener	100
Clock	2
Coffeemaker	850
Curling iron	40
Dishwasher	1200
Drill	240
Dryer	5000
Electric blanket	175
Electric heating:	
Heat pump (January average)	15000
Baseboard (January average)	15000
Furnace (January average)	15000
Fans:	
Attic	375
Circulating	88
Furnace fan (1/3 hp)	330
Freezer:	
15 cu. ft.	341
15 cu. ft. frostless	440
Garage door opener	350
Garden tools:	
Edger	190
Hedge trimmer	265
Griddle	1200
Hair dryer	1000
Hair rollers	350
Hi-fi stereo	100
Iron	1000
Power tools:	
Drill	240
Jigsaw	370

Electric Product	*Typical Watts*
Light bulb (100 watt)	100
Microwave oven	800
Motors:	
1/6 hp	170
1/4 hp	250
1/3 hp	330
1/2 hp	500
1 hp	1000
Popcorn popper	575
Radio	75
Ranges:	
Small surface unit	1300
Large surface unit	2400
Oven	3200
Broiler	3600
Refrigerator/freezer:	
14 cu. ft.	330
14 cu. ft. frostless	615
Self-clean cycle	4000
Sewing machine	75
Slow cooker: Low	75
Television:	
Black and white	160
Color	300
Solid state color	200
Toaster	1200
Toothbrush	7
Trash compactor	400
Vacuum cleaner	650
Waffle iron	1200
Washing machine	500
Water heater: Quick recovery	4500
Window	200
Yard lights:	
175W mercury (including ballast)	196
100W incandescent	100

Note: You could cosponsor an Energy Conservation Contest with the science department at your school. The following is a recommendation for the contest.

Energy Conservation Contest

Contest Description

The Energy Conservation Contest recognized students for completion of projects or activities that conserve energy or demonstrate an alternate form of energy. Entries will be judged on the display of a project or model showing techniques used, type and amount of energy saved, and implications of the design for the future. All entries will receive a ribbon. Trophies will be presented to the top three (3) entries.

Eligibility

Student:	No more than one (1) project per contestant.
Class:	Class competition will select the best 5 projects to compete with students from other classes.
School:	School competition will select the best 10 projects to compete with students from other schools.

Entry Requirements

1. The project should use a model, drawings, diagrams, and descriptive reports.
2. Regulations are purposely left flexible and open to encourage students to enter projects from their classes.
3. Activity or project may involve ways to produce power from alternate sources, or ways to conserve energy such as recycling.

Contest Procedures

A. Registration
   1. Preconference registration from other schools must be mailed or received a few days in advance to reserve space for project.
   2. On-site check-in must be completed at the Conference Information desk.
   3. Setup times can be obtained by contacting the Contest Coordinator. Also, projects need to be left at the competition site for judging during the time specified.

B. Competition
   1. Set up energy project or activity in judging room during specified time.
   2. Judges will rate each entry.
   3. Judges total Rating Sheets and give to Contest Coordinator.
   4. Contest Coordinator will tally ratings and attach ribbons to all entries.
   5. Contest Coordinator will pass all forms to the Accounting Committee.
   6. Accounting Committee identifies 1st, 2nd, and 3rd place winners.

C. Termination
   1. After judging, projects may be removed from judging room and may be placed in school exhibit.
   2. The top three projects should be available for publicity and recognition.
   3. Winners will be announced at the Awards Program.

D. Evaluation Criteria

Complexity of the process	15 points
Ingenuity	15 points
Practicality of process	5 points
Usability as product	5 points
Cost-effectiveness of process or product	20 points
Workmanship of product	20 points
	Total 80 points

E. Awards

1. Ribbons will be attached to all entries according to the points earned.

Award	Ribbon	Points
Excellence Award	Blue	69-80
Outstanding Achievement	Red	53-68
Meritable Quality	Yellow	32-52

Honorable Entry White 1-31 2. First, second and third place trophies will be presented to the top three (3) finalists for each level.

Resource Conservation Contest

Contest Description

The Resource Conservation Contest recognizes students who have used techniques for conserving resources and materials. Contestants will enter projects build from recycled materials with a Bill of Materials. Judges will rate each project on criteria and attach ribbons. Trophies will be presented to the top three entries.

Eligibility

Student:	No more than one (1) project per contestant.
Class:	Class competition will select the best 5 projects to compete with students from other classes.
School:	School competition will select the best 10 projects to compete with students from other schools.

Entry Requirements

1. Projects can relate to any instructional area.
2. Appropriate techniques of assembly or construction shall be used.
3. A Bill of Materials listing recycled or new materials will accompany project.

Contest Procedures

A. Registration

1. Preconference registration from other schools must be mailed or received a few days in advance to reserve space for project.
2. On-site check-in must be completed at the Conference Information desk.
3. Setup times can be obtained by contacting the Contest Coordinator. Also, projects need to be left at the competition site for judging during the time specified.

B. Competition

1. Set up energy project or activity in judging room during specified time.
2. Judges will rate each project and list of conservation techniques.
3. Judges total Rating Sheets and give to Contest Coordinator.
4. Contest Coordinator will tally ratings and attach ribbons to all entries.
5. Contest Coordinator will pass all forms to the Accounting Committee.
6. Accounting Committee identifies 1st, 2nd, and 3rd place winners.

C. Termination

1. After judging, projects may be removed from judging room and may be placed in school exhibit.
2. The top three projects should be available for publicity and recognition.
3. Winners will be announced at the Awards Program.

D. Evaluation Criteria

Efficient use of recycled materials	25 points
Practical application of project	20 points
Correct techniques in construction or assembly	15 points
Craftsmanship in project	10 points
Bill of Materials List	10 points
TOTAL	80 points

E. Awards

1. Ribbons will be attached to all entries according to the points earned.

Award	Ribbon	Points
Excellence Award	Blue	69-80
Outstanding Achievement	Red	53-68
Meritable Quality	Yellow	32-52

Honorable Entry White 1-31 2. First, second and third place trophies will be presented to the top three (3) finalists for each level.

Project ID _____ Judge's Rating Sheet
Energy Conservation Contest

For each criteria listed, please fill in a value from 0 to the maximum possible points for that criteria. The value in the total column should be the sum of the criteria points.

Complexity of the process	15 points	____________
Ingenuity	15 points	____________
Practicality of process	5 points	____________
Usability as product	5 points	____________
Cost effectiveness of process or product	20 points	____________
Workmanship of product	20 points	____________

TOTAL POINTS ____________ Comments:

Judge's signature ______________________________

Project ID _____ Judge's Rating Sheet
Resource Conservation Contest

For each criteria listed, please fill in a value from 0 to the maximum possible points for that criteria. The value in the total column should be the sum of the criteria points.

Efficient use of recycled materials	25 points	____________
Practical application of project	20 points	____________
Correct techniques in construction or assembly	15 points	____________
Craftsmanship in project	10 points	____________
Bill of Materials List	10 points	____________

TOTAL 80 points ____________ Comments:

Judge's Signature ______________________________

(2-3 DAYS)

NEWTON'S THIRD LAW

Essential Elements: 75.50(b): 2C, 4B, 6A, 7A, 7B
75.50(f): 1, 10

TAAS Objectives: Language Arts: RC 1, 2, 4, 5; WC 2-4, 6
Mathematics: C 1; O 1, 2

Activity Overview

Your students will use a simple balloon to help them understand a law of nature called Newton's Third Law of Motion. This law involves force, equilibrium, and propulsion. Through understanding this principle they will also understand more about rockets and space vehicles.

Challenge Statement

How is a rocket launched into outer space? How much force does it take to overcome the pull of gravity? How does the space shuttle change its direction while in outer space? How does the shuttle or rocket slow down enough to land in a specific location? Newton's Third Law of Motion helps to answer all those questions.

One day your students may be involved in the design and development of vehicles used in space travel. If not, there is a very good chance that *they* may travel that way. Your goal is to help your students grasp Newton's law of motion by using a very simple activity. This will help them understand many principles of aviation.

Systems Model

Resources
Students as designers and experimenters
Teacher as resource and facilitator
Variety of materials for design and experimentation

Processes
Study of Newton's Third Law
Application of simple math to the law of motion
Design of device to demonstrate the law of motion
Manipulation of and experimentation with given materials
Evaluation of motion device

Applications
Scientific principle to rockets and space travel
Simple math to a law of nature
Creativity to visibly demonstrate a law of nature

Impact
An understanding of air and space travel
Understanding creativity in the design process
Appreciation of gaining and applying knowledge

Interfacing with Other Disciplines

Mathematics: Students will apply simple math in an experiment to understand and demonstrate Newton's Third Law.

Science: Students will study the effects of Newton's Third Law.

Language Arts: Students will learn the meaning of new words and record information about Newton's Third Law.

Social Studies: Students will relate the past to the present.

Critical Thinking Skills Reinforced

Students will apply math and science to a simple activity to demonstrate Newton's Third Law of Motion. After studying Newton's Third Law, the students will design a device to demonstrate the principle. They will transfer and apply this knowledge to current and future aviation.

Teaching Tips

1. The day before the activity, give the students a handout of Newton's Third Law to review at home.
2. Direct a class discussion on propulsion applying Newton's Third Law. Work through math the problems on the chalkboard or overhead projector. Demonstrate propulsion.
3. Read and discuss the following:
   Sir Isaac Newton, an English scientist, stated three important scientific principles that govern the motion of all objects whether on earth or in space. These laws simply stated are:
   a. Objects at rest will stay at rest, or objects in motion stay in motion in a straight line unless acted upon by an unbalanced force.
   b. Force is equal to mass times acceleration.
   c. For every action there is always an opposite and equal reaction.
4. Give each student the materials to build the motion device and paper to sketch their ideas.
5. Assist and monitor the students in building creative devices. Provide corrective feedback if necessary.
6. Evaluate the devices for creativity and accuracy. The Observation and Evaluation Sheet will allow you to have an objective grade for this activity and determine the degree of understanding for each student.
7. Discuss the future of space exploration and the likelihood of space colonization.

Instructional Strategy

- Introduce the unit by relating Newton's Third Law to both the past and the present. The lesson will expand through the application of math skills to a scientific principle. The students will demonstrate learning through the simple activity and evaluation.
- Close the unit with a discussion of the future of aviation and space exploration.

Equipment/Supplies

1. Balloons
2. Tape
3. Twine/string
4. Soda straw
5. Pulleys
6. Pins
7. Dowel rod
8. Bottle
9. Pencils
10. Springs
11. Scissors
12. Tape

Evaluation Key

1. Force
2. Propulsion
3. Action
4. Reaction
5. Thrust
6. Equilibrium
7. 10 lb left
8. 11 lb right
9. No (in equilibrium)
10. The gases escaping from engine push against the engine itself, not the atmosphere around it. (Action/Reaction)

Support Materials

1. Estes Co. supplemental materials
2. *Principles of Technology* Teacher Materials

Modifications for Handicapped, Disadvantaged and LEP Students

Give evaluation orally to the LEP students. Some students may need help manipulating small objects.

Name________________________________

Observation and Evaluation Sheet

Write a brief description of what happened in the testing of your device in terms of propulsion.

____

____

____

____

Answer the following questions. Each correct answer is worth 10 points.

Fill in the blanks with the following words.

thrust
reaction
force
net force
action
pound
propulsion
Newton
equilibrium
SI

1.____________ is a push or pull that causes an object to change shape or position.

2.____________ is a motion that drives an object onward or forward.

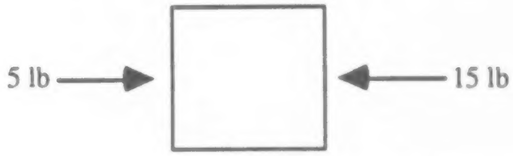
3.____________ is the effect or influence one object has on another.

4.____________ is an opposite force which one object exerts against a force acting upon it.

5.____________ is an applied force acting in a given direction that gives a reaction in an equal but opposite direction.

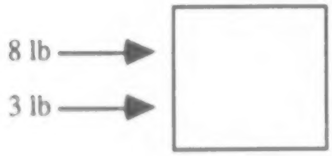
6.____________ when all forces acting on an object add up to zero, the object is said to be in _____.

7. What is the resulting force if a 5-lb force is pushing an object to the right and a 15-lb force is pushing the object to the left.



Calculate math here.

8. What is the resulting force if a 3-lb force pushing an object to the right is added to an 8-lb force pushing the object to the right?



Calculate math here.

9. Will a rocket clear a launch pad if its thrust is equal to the weight of the rocket? Explain your answer.

10. Explain how gases escaping from a rocket engine propel it forward.

NEWTON'S THIRD LAW

Use a simple balloon to help you understand a law of nature, Newton's Third Law of Motion, that involves force, equilibrium, and propulsion.

Challenge Statement

How is a rocket launched into outer space? How much force does it take to overcome the pull of gravity? How does the space shuttle change its direction while in outer space? How does the shuttle or rocket slow down enough to land in a specific location? Newton's Third Law of Motion helps to answer all those questions.

One day you may be involved with the design and development of vehicles used in space travel. If not, there is a very good chance that you may travel that way.

Objectives

- To gain a basic knowledge of the theory of propulsion
- To observe and explain Newton's Third Law of Motion
- To develop a better understanding of rocketry and space travel

Vocabulary/Concepts Reinforced

- *Newton's Third Law of Motion*—for every action there is an equal but opposite reaction. For an action, there must be a force applied greater than the force of gravitational attraction of the object acting upon it.
- *Force*—a push or pull that causes an object to change its shape or position.
- *Net force*—is the resulting force after adding or subtracting the forces acting on an object.
- *Equilibrium*—if the net force is equal to zero, then the object is said to be in equilibrium (balanced forces).
- *Propulsion*—a motion that drives an object onward or forward.
- *Action*—the effect or influence one object has on another.
- *Reaction*—an opposite force which an object exerts against a force acting upon it
- *Pound (lb)*—the unit of measure of weight in the English system of measurement.
- *Newton (N)*—the unit of measure of force in the SI measuring system.
- *Thrust*—an applied force acting in a given direction, but giving a reaction in an equal but opposite direction.
- *SI*—Systems International (metric system).

Equipment/Supplies

- Balloons
- Tape
- Twine/string
- Soda straw
- Pulleys
- Pins
- Dowel rod
- Bottle
- Pencils
- Springs

Introduction

Nearly 300 years ago, Sir Isaac Newton, an English scientist, stated three important scientific principles that govern the motion of all objects whether on earth or in space. These laws helped scientist and inventors of his time work with rockets and air travel. Now the same laws apply to modern rocketry and space travel. These laws simply stated are:

1. Objects at rest will stay at rest, or objects in motion stay in motion in a straight line unless acted upon by an unbalanced force.
2. Force is equal to mass times acceleration.
3. For every action there is always an opposite and equal reaction.

This exercise is to introduce you to Newton's Third Law of Motion, which involves how propulsion and forces act upon a rocket. The math you have learned will help you understand what he discovered, which determines how a rocket moves.

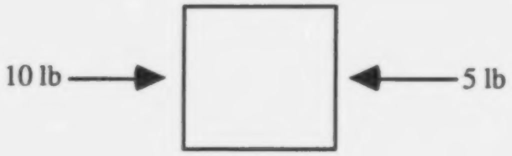
Procedure

1. Discuss the principle of propulsion.

Let's use simple addition and subtraction to help you understand Newton's Third Law of Motion. Study the example and be sure to ask questions if you do not understand.

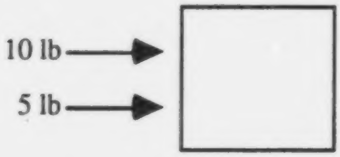
Newton's Third Law of Motion states that for every action there is an equal but opposite reaction. Let's look at this law in more detail. For there to be an action, there must be a force applied greater than the force of gravitational attraction of the object it is acting upon. The units we measure these forces with is the pound (lb) in English units of measurements and the Newton (N) in the SI measurement system. These units can be mathematically added together or subtracted.

Example 1



Force = 10 lb right - 5 lb left
Force = 5 lb right

Example 2



Force = 5 lb right + 10 lb right
Force = 15 lb right

The result of adding or subtracting these forces is called *net force*. If the net force is equal to zero, then the object it is applied to is said to be in ***equilibrium***. For example, your desk is in equilibrium. The same amount of force is pushing up on your desk as the desk is pushing down on the floor. If this were not true, the desk would either sink into the floor or fly up.

The way Newton's Third Law of Motion is applied to a rocket is that gases escaping from a rocket engine push against the rocket, not the atmosphere around the rocket. When this action takes place, it is called *thrust*. Thrust is caused when there is an applied force acting in a given direction, but giving a reaction in an equal but opposite direction. When these factors are taken into consideration, the net force must be greater than zero for a rocket to be propelled upward. This propelling force is defined as *propulsion*.

2. Now get a packet of materials from the instructor. Using the materials found in the packet, design a device that will demonstrate propulsion.
3. Sketch your idea on a sheet of paper. On the back of the page, describe what you think will happen.
4. Using materials found in the packet, build the device.
5. Demonstrate and explain the operation of the device to the class.
6. Complete the Observation and Evaluation Sheet.
7. Discuss the future of space exploration and the likelihood of space colonization.

Evaluation

1. You will be evaluated on your behavior and participation during the class.
2. You will be graded on your sketch and description of the device you design.
3. You will be graded on the Observation and Evaluation Sheet.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 12
(2-3 WEEKS)

STYRO-JETS

Essential Elements: 75.50(b): 2A, 2C, 2D, 4B, 6A, 6E, 7A, 7B, 8A, 8B
75.50(f): 1, 2, 6, 10
TAAS Objectives: Language Arts: RC 1-5; WC 1-7
Mathematics: C 1-5

Activity Overview

Your students will be involved in designing, building, and testing a Styrofoam model of a prototype jet airplane. They will be presented with a communication and design problem in which they will design and perform test flights on a compressed air-powered airplane model, make modifications, and record results.

Challenge Statement

This activity is designed around futuristic aircraft because so many of the concepts relating to aircraft are part of the Industrial Technology curriculum and it is of interest to a large number of students. This activity allows the teacher to direct the students into special areas of interest, such as career opportunities and aviation.

Systems Model

Resources

Students as designers and aviation eengineers
Teacher as department head, resource person, and monitor
Material for plane construction
Equipment and tools for construction and launching
Written materials for resources and evaluation

Processes

Study new terms and concepts
Design styro-jet
Build styro-jet prototype
Perform test flights on prototype
Chart flight results
Evaluate flight
Write summative technical report

Applications

Aviation terms and concepts to problem-solving activity
Creative design to problem solving
Design to prototype
Modifications to prototype
Flight information to charts and graphs
Experiential conclusions about aviation to knowledge base
Math and science to technology

Impact

Career choices

Transportation
Generalizations of aviation
Space development
Science theories

Interfacing with Other Disciplines

Mathematics:	Students will use measurement to design and build their prototypes. They will analyze flight and chart the results.
Science:	Students will study the aviation principles of lift, drag, thrust, and gravity. They will become familiar with these principles through application using the styro-jet.
Language Arts:	Students will learn a new vocabulary and write a technical report detailing the design, construction, and testing phase of their styro-jet.
Social Studies:	Students will learn how the scientific principles of the past affect the discoveries of the present and the future.

Critical Thinking Skills Reinforced

Students will evaluate the effect of certain scientific principles on flight through the application of these principles. The vehicle for application is the design, construction, and testing of the styro-jet. On completion of the testing, the students will record their results and conclusions both in chart form and in a technical report.

Teaching Tips

1. Review safety rules for appropriate tools and machines before use. Tie "industrial/business language" found in the introductory memo to appropriate school terminology.
2. When discussing scientific principles, relate the time frame to technological developments of the past. Plot the growth of aviation, and help the students project future inventions. Consider the impact of aviation on society.
3. Have extra Styrofoam meat trays available for revised prototypes and second chances. Limit the number of plane attempts to two or three per student. Display as many aircraft-related posters in the design area as possible. Use straight pins and paper clips to help balance the planes and improve the flight patterns. The flight area should be about 100 feet by 45 feet.
4. High ceilings are best. The gym or the cafeteria is suitable. Regulate the tank pressure based on the size of the flying area; 25-30 psi is ideal.
5. Emphasize the importance of keeping the written work current and intact. Relate the paperwork to business and industry for developmental purposes.

Instructional Strategy

- Open the unit with a group discussion to present the activity to the class.
- Use "Principles of Flight" software to introduce and reinforce new vocabulary and concepts.
- Have a student (designer)/teacher (department head) conference to evaluate and monitor student designs after the thumbnails sketches are complete.
- Use appropriate work stations. Organize all needed tools and materials at each workstation.
- Use the activity as a contest to motivate the students. The grant from the memo is a prize that you feel is appropriate. It could be a pizza of movie pass or extra credit. The recognition for a job well done is a photograph for the newspaper.
- Have students write a summative report that tells how their activity relates to the process of designing to meet concerns of the world.
- Present different sections of the unit at the first of each class. Use the remainder of class time as student work time.
- Groups work very well with this unit. Be sure to require that the number of prototypes developed by the group is equal to the number of students in the group.

Equipment/Supplies

1. Magazines such as *Popular Science, Air and Space, and Mechanix Illustrated*
2. Student supplies for each work station
3. Used 6x8 Styrofoam meat trays (cleaned)
4. Paper
5. Pencil
6. Tape
7. White glue
8. Scissors
9. X-acto knife
10. Cutting mat
11. CAD station
12. 3/4" x 6 PVC pipe
13. Compass set
14. Drafting set
15. Hot glue gun and glue sticks
16. Straight pins
17. Paper clips
18. Aircraft posters
19. Sandpaper
20. Launch system

Evaluation Key

1. Each level or section of the activity should be checked and graded for progress and mastery.
2. All design papers should be graded based on your normal set of drafting grading criteria, but be sure to include completeness, accuracy, and thought processes. Be sure the students have thought about what is on their paper rather than just writing something down.
3. Prototype should be evaluated before the test flight for craftsmanship. It should be graded again after the flights for evidence of corrective modifications. (Many times the planes will look entirely different after the testing process.) Charting should be checked for thoroughness and accuracy.
4. The Vocabulary Worksheet will serve as an objective grade.
5. The technical technical report should be graded, using the holistic method to check content. Writing skills should also be corrected as that is a valuable job skill in engineering and middle management positions. No student will fail the report for poor writing, but should understand the importance of written communication in industry and be referred to the language arts teacher for help. Some language arts teachers may allow the students to work on their reports as a grade in both classes. You will get much better work that way.

Vocabulary Worksheet Key

1. H
2. M
3. A
4. O
5. P
6. C
7. I
8. N
9. E
10. G
11. R
12. J
13. D
14. T
15. F
16. B
17. K
18. S
19. Q
20. L

Support Materials

Handouts or Overhead Transparency Masters:

- Bernoulli's Principle
- Jet Propulsion Force Summary
- Diagram Pattern
- Development of a Cylinder Pattern
- Development of a Cone
- Test Flight Data Sheet
- Corrective Modification Tips
- Flight Summary Sheet
- Vocabulary Worksheet
- Launch System Detail Sheet

Software:

1. "Discover CAD," Hearlihy and Co., 714 W. Columbia St., Springfield, OH 45501
2. "Principles of Flight," AV Systems Inc., 1445 Estrella Drive, Santa Barbara, CA 93110
3. AppleWorks, Microsoft Works, or any other good word processing program

Modifications for Handicapped, Disadvantaged, and LEP Students

Have extra Styrofoam to give to students who do not use meat in the home. Certain students will need extra assistance in evaluating which of their designs are the best. These students tend to also need special help during the corrective modification stage. G/T students may be challenged by assigning them to the role of corrective modification specialist.

Name________________________________

Vocabulary Worksheet

Directions: Fill in the blanks using the proper letter of the vocabulary word or term from the list provided. It may be necessary for you to refer to your class notes.

1.________ An airfoil ahead of the main wing

2.________ Sir Isaac Newton's statement that "for every action, there is an equal and opposite reaction"

3.________ The upward force action upon a wing

4.________ A special type of fan used in a jet engine

5.________ Greek mathematician who built the first jet engine in the 1st century A.D.

6.________ The force that pushes an airplane forward

7.________ An item that is the first of its kind

8.________ A device that forces more air into an area than it would normally hold

9.________ A scientific principle that explains the theory of lift

10.________ A surface that extends up from the tail of an airplane

11.________ The simplest form of jet engine

12.________ A principle that states that "both halves of an object are identical"

13.________ Natural weight making an airplane go down

14.________ A jet engine that forces extra air into the center of the engine

15.________ The shape of an airplane wing

16.________ Natural resistance of air on an airplane

17.________ 14.7 psi—the natural state of our atmosphere

18.________ The most powerful jet engine

19.________ A power system used to move airplanes

20.________ When the lift of an airplane is less than the force of gravity

A. Lift
B. Drag
C. Thrust
D. Gravity
E. Bernoulli's principle
F. Airfoil
G. Vertical stabilizer
H. Canard
I. Prototype
J. Symmetry
K. Air pressure
L. Stall
M. Third Law of Motion
N. Compressor
O. Turbine
P. Hero
Q. Jet propulsion
R. Ramjet
S. Turbofan
T. Turbojet

Departmental Memo

TO: All Aircraft Design Personnel
FROM: Design Department Head
Subject: Governmental Research Grant

The U.S. Department of Aviation has announced a new Research and Development grant. This grant is for an unlimited amount of money and will be awarded to the designer of the best prototype flat-bodied airplane.

All prototypes will be evaluated on design, construction, and actual operation. Points will be awarded on a scale of 0–100, with the highest point score winning the grant.

Applications for the grant must be submitted within the next two weeks. All applications must include the following:

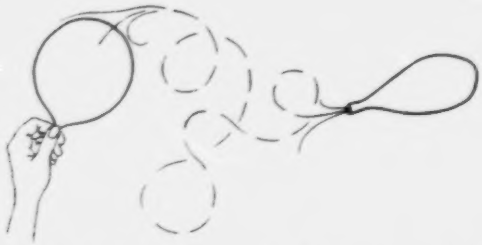
1. Completed sketch sheets
2. Completed technical drawing
3. Styrofoam prototype
4. Completed test flight data sheets

Since this grant will result in considerable amounts of money and company prestige, it will be necessary for you to work in total seclusion. Please remain in your assigned design area until all designs are completed. Be sure to observe all company policies regarding industrial espionage.

Best of luck to all designers, and remember that if I can assist you in any way, please call on me.

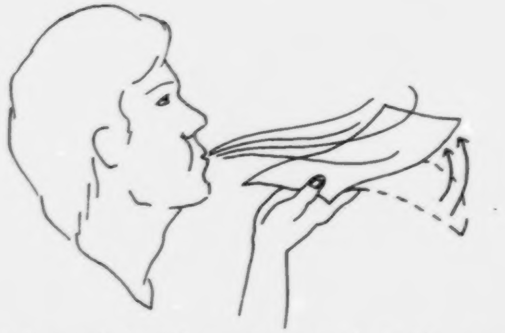
Vocabulary Illustrations

#1 Newton's Third Law



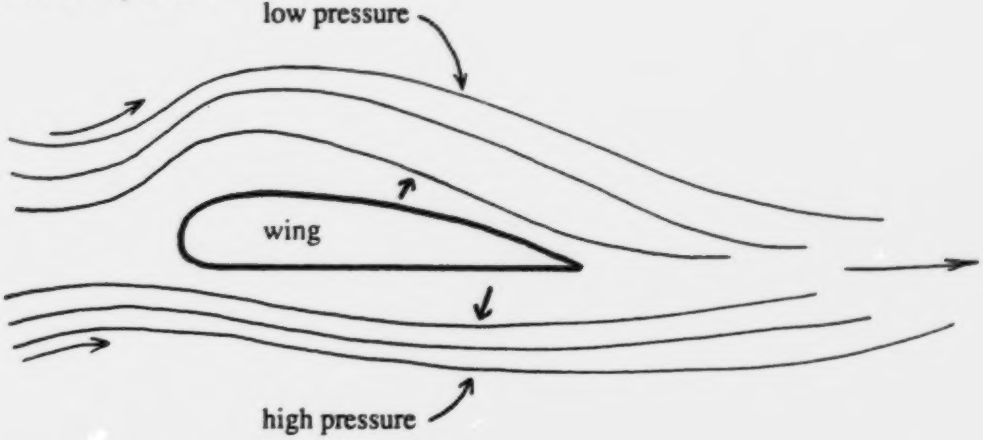
The simplest jet engine is a balloon. When released, the compressed air inside escapes, causing thrust. This action, blowing up the balloon, causes a reaction, thrust. This is a demonstration of Newton's Third Law.

#2 The Theory of Thrust



You can prove that this principle works! All you have to do is blow over the top of a sheet of paper. Watch the paper rise upward as the pressure is reduced on the top side.

#3 The Theory of Lift

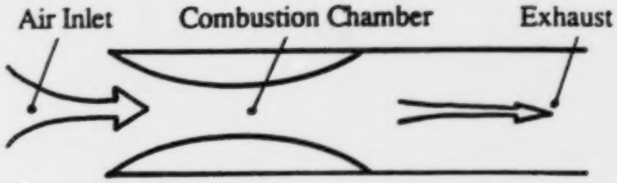


A wing works in much the same way. Air (wind) hits the front of the wing and splits. The air that moves across the top of the wing must travel farther and faster than the air on the bottom side. This causes high pressure on the bottom and low pressure on the top. Lift is the resulting force.

Vocabulary Illustrations

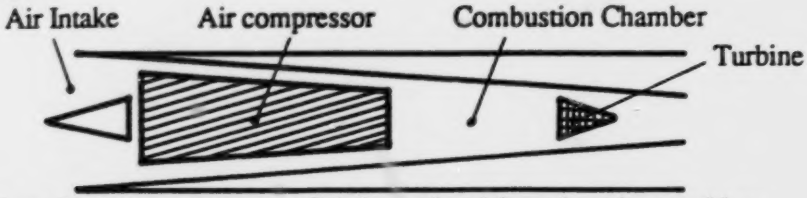
#4 Jet Engine Types

Ramjet Engine


Air Inlet
Combustion Chamber
Exhaust

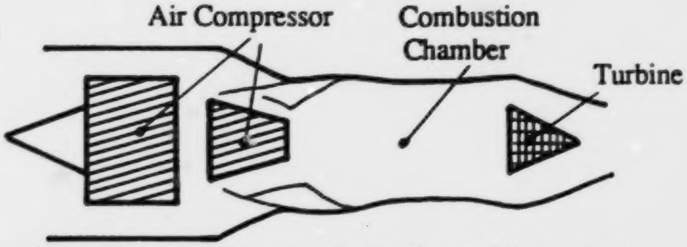
Air is forced into the engine as it moves through the air.

Turbojet Engine


Air Intake
Air compressor
Combustion Chamber
Turbine

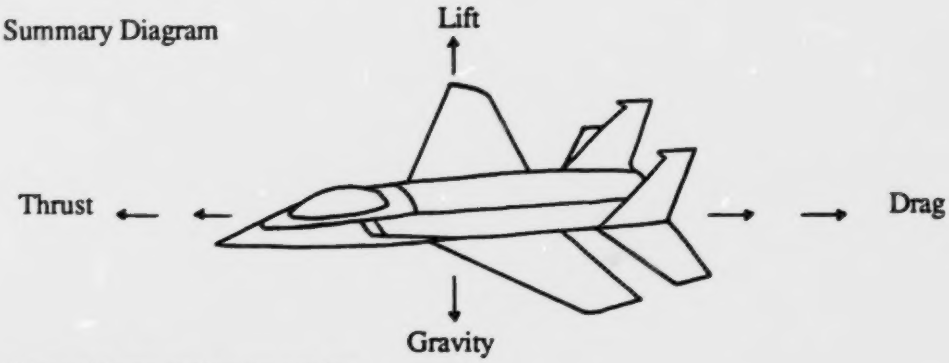
A turbojet has air forced in be a compressor. It is burned and forced out by a turbine.

Turbofan


Air Compressor
Combustion Chamber
Turbine

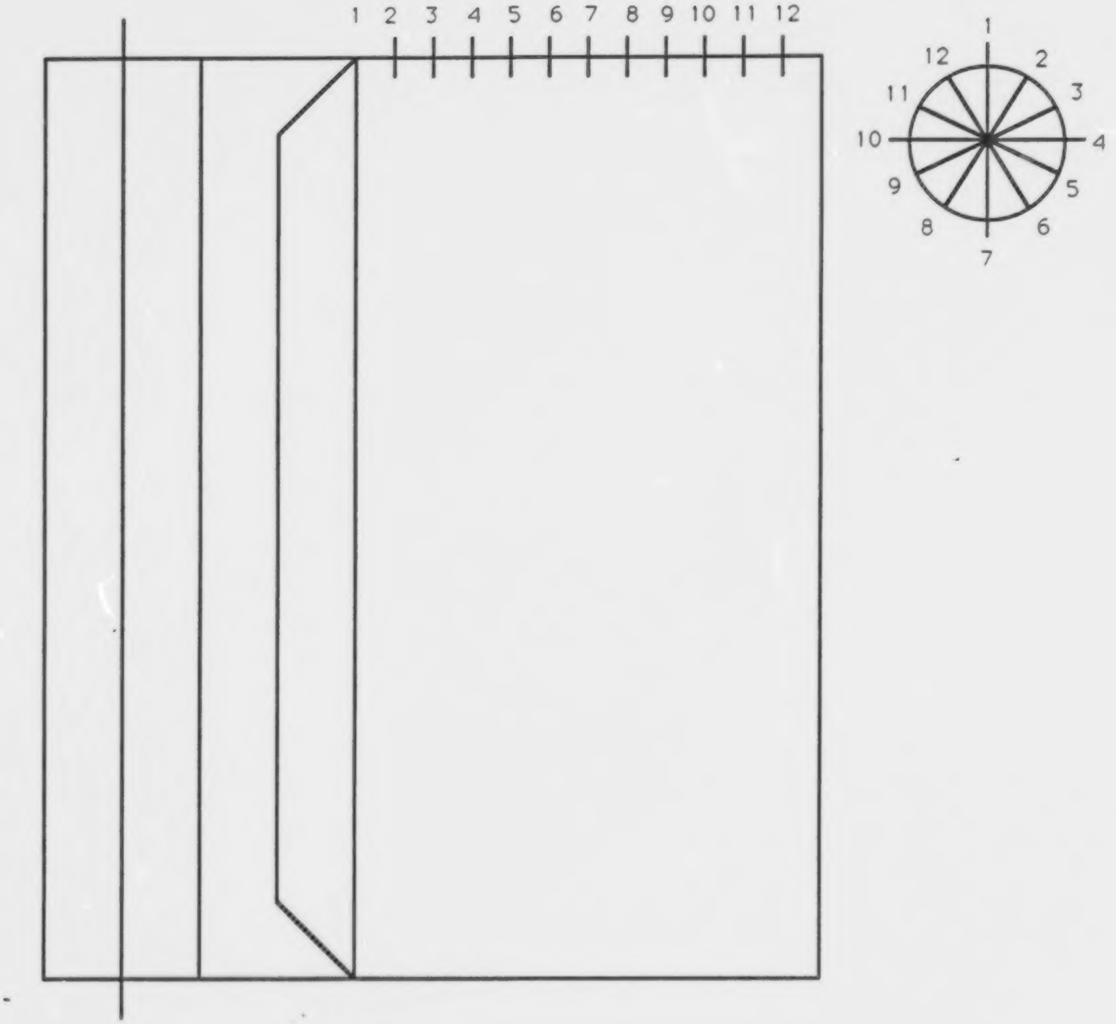
A turbofan has an additional compressor mounted in front of the engine.

Force Summary Diagram


Lift
Thrust
Drag
Gravity

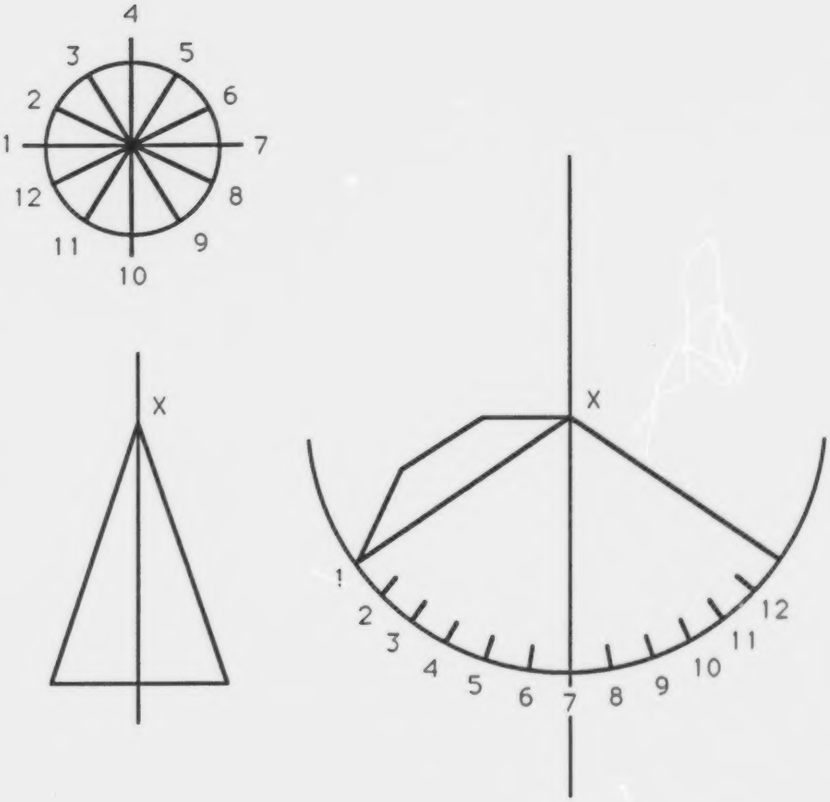
Lift—Upward force acting on a wing
Thrust—A created force pushing an airplane along
Drag—Natural resistance of air on an airplane
Gravity—Natural weight forcing an airplane to go down

Pattern Development of a Cylinder



1. Draw a 1" diameter circle for a top view.
2. Draw a 1" x 6" rectangle for the front view.
3. Divide the top view into 12 equal parts as your triangles.
4. Project the top and bottom lines of the front view to the right.
5. Draw a vertical line to start the pattern development.
6. Set your dividers equal to one of the spaces created on step three.
7. Mark off 12 of these spaces along the top line of the pattern development.
8. Draw a vertical line to end the pattern development.
9. Add a 3/8" wide space along one edge of the pattern to serve as a glue tab.
10. Cut the pattern development out, and follow the directions for taping it together.

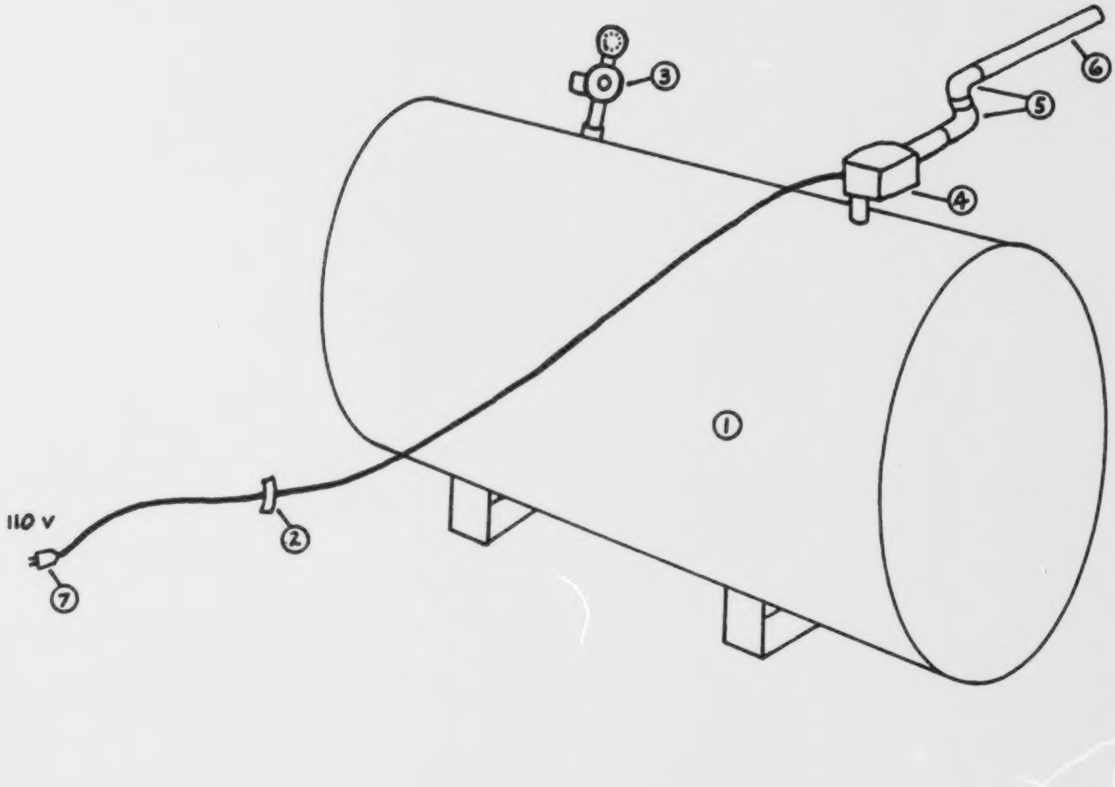
Pattern Development of a Cone



1. Draw a 1" diameter circle for a top view.
2. Draw a 1" wide and 1 1/2" high triangle for the top view.
3. Divide the top view into 12 equal parts using your triangles.
4. Draw a vertical center line for the pattern development.
5. Set your compass for the length of one side of the front view.
6. Draw an arc of this length on the vertical center line created in step 4.
7. Set your dividers equal to one of the spaces created in step 3.
8. Mark 12 of these spaces on the center line of the pattern development (place 6 on the left side and 6 on the right).
9. Add a 1/4" tab onto the left side of the pattern development.
10. Cut the pattern out, and follow the directions for taping it.

Launch Detail

Key	Part	# Required
①	Air Tank	1
②	Momentary Contact Switch	1
③	Air Regulator with Gage	1
④	Gas Valve	1
⑤	90° Threaded Elbow 3/4 PVC	2
⑥	3/4" PVC Pipe - 10" long	1
⑦	Male Cord Plug	1



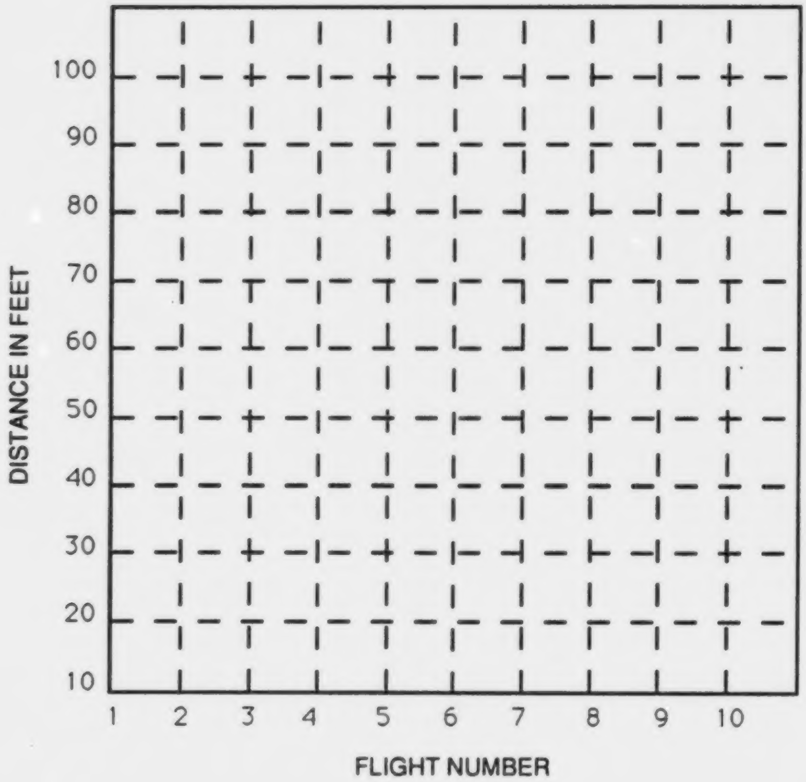
TEST FLIGHT DATA SHEET

FLIGHT NUMBER	FLIGHT PATTERN	CORRECTIVE MODIFICATION	DISTANCE TRAVELED
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Test Flight Data Sheet

Flight Summary Sheet

1. Complete this graph with information from your Test Flight Data Sheet.

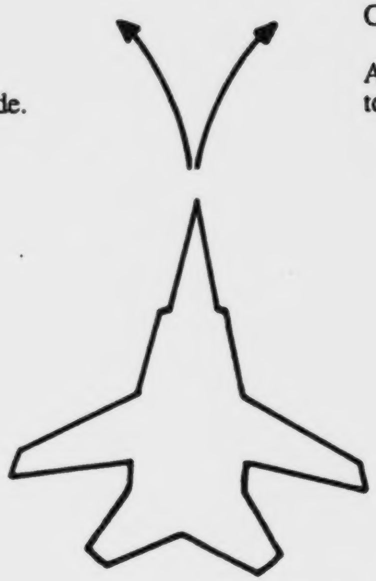


2. Calculate your average flight distance (sum of distances divided by the number of flights).

3. Calculate your glide efficiency. The higher the number, the better the efficiency.

Corrective Modification Tips

What do you do if your plane flies flat, but it...



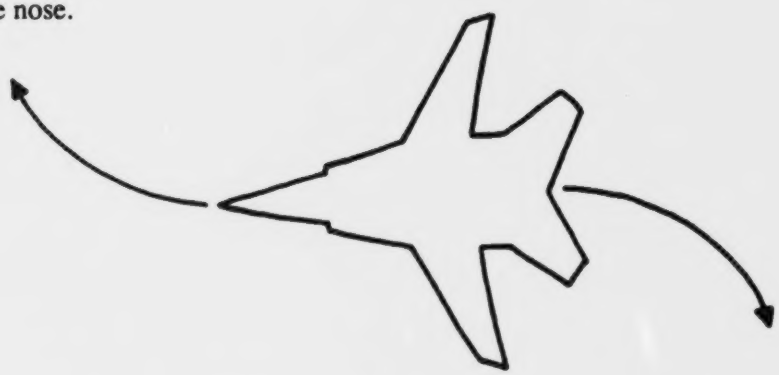
Curves left/

Add weight
to the right side.

Curves right/

Add weight
to the left side.

But, what if it...



Climbs too fast?
Add weight
to the nose.

Dives?
Add weight
to the tail.

If the plane rolls, combine these tips Careful use of these tips and patience will allow you to make your plane

SOAR

STYRO-JETS

Participate in designing, building, and testing a Styrofoam model of a prototype jet airplane. Design and perform test flights on a compressed air-powered airplane model, make modifications, and record your results.

Challenge Statement

Transportation has changed drastically over the last 90 years. With the fast pace of technological developments, you will see even greater changes in the years to come. Aviation designers and engineers learn the basics of aviation, before developing planes, shuttles, satellites, and other space ships. The basics are scientific theories that were formulated hundreds of years ago. When we apply these theories to technology, we not only understand them better, but also open ourselves to the ideas of the future.

Objectives

- To design and construct a prototype aircraft
- To use a CAD work station to produce a technical drawing of a chosen aircraft
- To recycle Styrofoam to produce a prototype plane
- To learn and apply the basic principles of aerodynamics to perfect the flight of the prototype
- To produce graphs and charts
- To prepare a summative technical report

Vocabulary/Concepts Reinforced

- Lift
- Drag
- Thrust
- Gravity
- Bernoulli's principle
- Airfoil
- Vertical stabilizer
- Canard
- Prototype
- Symmetry
- Air pressure
- Stall
- Third Law of Motion
- Compressor
- Turbine
- Hero
- Jet propulsion
- Ramjet
- Turbofan
- Turbojet

Equipment/Supplies

- Used 6×8 Styrofoam meat trays (cleaned)
- Paper
- Pencil
- Tape
- White glue
- Scissors
- X-acto knife
- Cutting mat
- CAD station
- 3/4" × 6 PVC pipe
- Compass set
- Drafting set
- Hot glue gun and glue sticks
- Straight pins
- Paper clips

Introduction

Read the Departmental Memo.

Procedure

1. Review and discuss the vocabulary list along with the vocabulary illustration sheets. Look up any terms you do not understand. Be sure to ask questions about concepts that do not make sense to you. You will design a better plane and be more successful with your prototype plane if you understand these words and theories.
2. Review the Departmental Memo. Note that all applications must include the following:
    a. Completed sketch sheets
    b. Completed technical drawing
    c. Styrofoam prototype
    d. Completed test flight data sheets
3. Start your designs by sketching. Use thumbnail (small and simple) sketches. Do a minimum of *four* different sketches. Use your own ideas, or modify ideas from pictures of existing airplanes. Remember to sketch the plane as it would be seen in the top view.
4. Schedule a conference with your instructor to discuss each of your ideas. The Department Head will help you make decisions about which of your ideas will work best.
5. Make a full-size sketch of your two best ideas. Full size is about 6" by 8".
6. Study each of your full-size sketches. Decide which idea will perform the best.
7. Make a full-size technical drawing of the plane—top view only—using the CAD system. Use Draw Line, Erase Line, Draw Arc, Erase Arc, and any other commands needed to draw one side of the top view of your plane. Use the Window and Mirror Copy commands to get the other half of your plane. This will assure symmetry. (If a CAD system is not available, you must draw one side of the plane and plot the points for the other side to assure symmetry.) Plot the drawing on "B" size paper.
8. Present your thumbnail sketch sheet, your technical sketch sheet, and your technical drawing to your instructor for evaluation.
9. Cut out the shape of your plane. Use the plot generated by the CAD system. This will serve as your template.
10. Place the template on a piece of Styrofoam. Trace around the edge with a ballpoint pen. Be sure to locate and mark the center line.
11. Place the Styrofoam on a cutting mat. Use a sharp X-acto knife to cut out the plane. Be sure to observe all safety procedures. Also, be sure to hold the knife straight at a 90-degree angle, since any other angle on the wing edges will affect later flights.
12. Put the body away for now.
13. Study your copy of the sheet titled Pattern Development of a Cylinder. Using this information, make a pattern for your jet engine body. This sheet contains step-by-step instructions. Place a checkmark beside each step number after you complete that step. Cut out the pattern, and put it away for now.
14. Study your copy of the sheet titled Pattern Development of a Cone. Using this information, make a pattern for your engine body nose cone. This sheet contains step-by-step instructions. Place a checkmark beside each step number after you complete that step.
15. Cut out the pattern and put it away for now.
16. Apply white glue to the tab of the cylinder pattern. Wrap this around a length of 3/4" PVC pipe. Use heavy masking tape to wrap around the body. Be as neat as possible. **Do not spirally wrap the body. Cut and wrap individual pieces of tape to fit neatly around the tube.**

17. Apply white glue to the tab of the nose cone pattern. Fold the pattern into a cone shape. It will be necessary to do this on one end of the tube section while the tube section is still on the PVC pipe. Using heavy masking tape, tape around the cone, letting each piece of tape lap onto the body section. Be as neat as possible. Cover the cone with two layers of tape.
18. Cover the body section again with another layer of tape. This time you must stretch the tape as tightly as possible.
19. Glue the completed engine section to your plane body using hot glue. Place the hot glue on the engine body rather than on the plane body. Be sure to glue the engine body directly on top of the center line of the plane body. When the glue has cooled and set, remove the PVC pipe from inside the engine body.
20. Let your instructor evaluate your prototype.
21. Launch your plane. Refer to the Launch Detail sheet. Carefully watch how the plane flies. Record the flight characteristics (pattern) and the distance traveled on the Test Flight Data Sheet.
22. Refer to the Corrective Modification Tips to determine what modifications are needed to correct the flight problems. Perform the modifications on your plane, and record this on the Test Flight Data Sheet.
23. Repeat this at least ten times, being sure to fill out the Test Flight Data Sheet.
24. Transfer the information found on the Test Flight Data Sheet to the graph found on the Flight Summary Sheet. Calculate the average flight distance (AFD) and the glide efficiency (ER).
25. Let your instructor evaluate the Test Flight Data Sheet and the Flight Summary Sheet.
26. Complete the Vocabulary Worksheet. When finished, this should be returned to your instructor for evaluation.
27. Write a summative report dealing with your prototype styro-jet. This report should:
    a. show how you applied the knowledge found on the Vocabulary Worksheet to your prototype.
    b. point out how your design or prototype could affect society or the environment if it was actually put into production.
28. Turn in the sketches, CAD drawings, prototype, chart, graph, and report to your instructor.

Evaluation

You will be evaluated and graded at the completion of each section of this unit. These sections and the appropriate grading critera are:

1. *Design*—Standard drafting rules must be used in your drawings. Is your work good? Are your drawings neat and accurate?
2. *Construction*—Craftsmanship is important. Is your work good? Does your prototype match your drawings? If you saw your prototype lying on a table, would it attract your attention? Would you think it was good even if it wasn't yours?
3. *Testing and Improvement*—Did you apply the flight principles and make modifications to your plane if necessary? Did you improve the plane?
4. *Vocabulary*—Did you answer the questions on the Vocabulary Worksheet correctly?
5. *Summative Report*—Does your report show an application of the knowledge you gained from designing, constructing, testing, and modifying your plane? Can you explain what you have learned and how it could affect our world?

This is the same type of evaluation that would be expected in business. Do it well. You will develop good work habits. In school you are rewarded with good grades for good work; in business you are rewarded with money and promotions!

POWER TRANSMISSION SYSTEMS

Essential Elements:	75.50(b): 2C, 4A, 4B, 6A, 6B, 6D, 7A, 7B, 8A, 8B 75.50(f): 8-11
TAAS Objectives:	Language Arts: RC 1-5; WC 1-3 Mathematics: C 2, 4; PS 2, 3, 4

Activity Overview

This learning activity will study three types of power transmission systems: (1) chains and sprockets, (2) gears, and (3) belts and pulleys. Students will read material about the various systems and conduct experiments to observe the function of various transmission devices.

Challenge Statement

Many devices and machines today use mechanisms that transmit power from the source to the point of use. Mechanisms common today include chains, sprockets, gears, and belts and pulleys. Machines often have large numbers of transmission devices connected so that they operate various parts of the machinery. The automobile is an example of a machine using all three types. The timing chain is used to help the engine functions occur in the correct sequence. Gears are used in the transmission, while belts and pulleys are used to drive such devices as the water pump, alternator, power steering pump, and air-conditioning compressor. The three types of power transmission systems are an important part of industrial and consumer machines.

Systems Model

Resources
Students as learners, observers, and experimenters
Teacher as resource and monitor
Tools, supplies, and equipment to conduct power transmissions systems demonstrations

Processes
Transfer of motion experiments and demonstrations
Observation
Recording information

Applications
Power transmission systems to automotives, appliances, and industrial machinery and devices

Impact
Development of machinery for manufacturing, transportation, and construction
Appreciation and understanding of technology

Interfacing with Other Disciplines

Language Arts:	Students will learn new vocabulary and concepts. They will read technical information and conduct sequential experiments.
Mathematics:	Students will use all basic math processes, fractions, ratios, and equations to understand power transmission systems.
Social Studies:	Students will study the development of machines and their impact on societies.

Critical Thinking Skills Reinforced

Comprehension: Understanding and rephrasing information presented in reading
Application: Use of mathematical formula to solve problems
Analysis: Identifying function of individual parts of gear trains and other transmission systems to determine overall effect of system

Teaching Tips

1. If a set of gears is not available, a low-cost alternative is to use wheels from a Spirograph set. Although each wheel does not have a hole in the exact center, one of the holes is very close and can be used (or a small hole could be drilled in the center). The wheels can be anchored to a sheet of cardboard using straight pins (short pins about 3/8" long are available for craft use). The number of teeth per wheel will vary from the values given in the student worksheet, but many combinations are possible with one set of Spirograph wheels.
2. A source for a variety of gears, sprockets and pulleys might be a gear manufacturing or machining shop. Companies which specialize in repairing large equipment may also have used parts available for donation to schools for samples.
3. A bicycle repair shop may be willing to donate the chain and sprockets needed from a 20" bicycle.
4. Caution students about the dangers of physically manipulating chains, gears, sprockets, etc. Fingers, clothing, and hair can be caught if precautions are not taken.

Instructional Strategy

- This unit has a significant amount of vocabulary development and technical reading material. It will probably be helpful if the teacher also demonstrates and further explains some concepts. As an example, the idea of "side thrusts" on gears may need further explanation for some students, especially those with limited skills in reading comprehension.
- As an extension activity, students can be asked to design some type of device (or "gadget") to accomplish an assigned task. The design should be such that it uses gears, pulleys, etc. to transmit motion from one part to another in the device. Sketches and an explanation of the device would be turned in.
- As a further extension activity, students can produce their own "gears" and "pulley systems" using common materials such as dowels, pins, wood, rubber bands, etc. and demonstrate their devices to the class.

Equipment/Supplies

1. Samples of the following chain types:
   Block Detachable Link Pintle
   Roller Rollerless Silent
2. Samples of the following sprocket types:
   Plate center Webbed body Hub design (type A, B, and C)
3. A mounted front and rear sprocket of a bicycle with drive chains:
   a. large sprocket from a 20" bicycle - 36 teeth
   b. small sprocket from a 20" bicycle - 18 teeth
   c. drive chain from a 20" bicycle
   d. mounting board 1.5cm × 25cm × 60cm
   e. mounting nuts and bolts to fit
4. Gear mounting board (or see teaching tips for alternative supplies)
5. 42-teeth gear
6. 31-teeth gear
7. Pencil and paper
8. Pulley board

Evaluation Key

The student should complete the worksheet as he or she works through the experiments. The worksheet answers are given below.

Chain Drives:

1. more powerful
2. chain
3. torque
4. small
5. slower
6. weather
7. roller
8. pin
9. twice
10. size selection
11. rollerless
12. silent

13.-14. noise vibration
15.-16. width pitch
17. solid
18.-20. Type A, Type B, Type C
21. direction of travel
22. correct or proper
23. lubricated, or aligned, or installed
24. slip
25. lubrication

Gear Drives:

1. gears
2. direction
3. force
4. reduced speed
5. torque
6. straight
7. angle
8. double
9. turn
10. angle
11. nonintersecting
12. rotary
13. failure
14. distance
15. torque
16. change in direction
17. on/off switching
18. opposite direction
19. one
20. counterclockwise
21. speed
22. 1.35 = 42/31
23. clockwise
24. force
25. 0.74 = 31/42
26. counterclockwise
27. clockwise
28. opposite
29. same
30. 1.35
31. 1
32. 0.66 = 42/64
33. Answers will vary, but should state that both cannot turn the same direction if they mesh with each other.
34. Answers will vary.
35. Answers will vary, but should state that gears will not turn meshed as shown.

Belts and Pulleys:

1. power
2. three (3)
3. round
4. flat
5. wedging
6. shocks
7. tension
8. compression
9. teeth
10. pulley
11. sheave
12. split

Support Materials

1. Bohn, Ralph C., and MacDonald, Angus J. *Power Mechanics of Energy Control.* 2nd ed. Bloomington, Ill.: McKnight, 1983.
2. *PTDA: The Official Power Transmission Handbook.* Julian J. Jackson Publications.
3. Seuss, Alan, et al. *Introduction to Power Systems.* Beverly Hills: Benziger Bruce and Glencoe, 1976.

Modifications for Handicapped, Disadvantaged, and LEP Students

Students with limited physical ability will probably need assistance in setting up the gear and chain systems on mounting boards. Working with other students in pairs or small groups will be helpful.

POWER TRANSMISSION SYSTEMS

Study three types of power transmission systems: (1) chains and sprockets, (2) gears, and (3) belts and pulleys, conduct experiments to observe the way the various transmission devices work, and try to predict what will happen when parts are combined in different ways to form a system.

Challenge Statement

Many devices and machines today use mechanisms that transmit power from the source to the point of use. Mechanisms common today include chains, sprockets, gears, and belts and pulleys. Machines often have large numbers of transmission devices connected so that they operate various parts of the machinery. The automobile is an example of a machine using all three types. The timing chain is used to help the engine functions occur in the correct sequence. Gears are used in the transmission, while belts and pulleys are used to drive such devices as the water pump, alternator, power steering pump, and air-conditioning compressor. The three types of power transmission systems are an important part of industrial and consumer machines.

Objectives

- To study and learn the three types of power transmission systems
- To learn the main factors used to identify gear drives, chain and sprockets, and belts and pulleys
- To learn the functions of all three power transportation systems
- To learn the advantages and disadvantages of the three power transportation systems

Vocabulary/Concepts Reinforced

- Chain
- Pitch
- Block chain
- Roller chain
- Mesh
- Power train
- Herringbone gear
- Rack and pinion
- Transmission
- V-belt
- Planetary gears
- Chain drive
- Sprockets
- Pintle chain
- Rollerless chain
- Hub
- Spur gear
- Bevel gear
- Gear train
- Round belt
- Timing belt
- Belt
- Link
- Torque
- Detachable link chain
- Silent chain
- Gear drive
- Helical gear
- Worm gear
- Side thrusts
- Flat belt
- Pulley

Equipment/Supplies

- Samples of the following chain types:
  Block Detachable Link Pintle
  Roller Rollerless Silent
- Samples of the following sprocket types:
  Plate center Webbed body Hub design (types A, B, and C)
- A mounted front and rear sprocket of a bicycle with drive chains:
  - large sprocket from a 20" bicycle—36 teeth
  - small sprocket from a 20" bicycle—18 teeth
  - drive chain from a 20" bicycle
  - mounting board 1.5 cm × 25 cm × 60 cm
  - mounting nuts and bolts to fit
- Gear mounting board (or sample set provided by your teacher)
- 42-teeth gear
- 31-teeth gear

- Pencil and paper
- Pulley board

Introduction

A large segment of power transmission equipment in use today is composed of chain drives. This type of drive will transmit extremely high torque in relation to cost. A large variety of styles, sizes, and materials are available.

Gear drives were one of the earliest forms of power transmission, and they are one of the most common ways to transmit power today. Gears are commonly used for high-power applications in homes and industry. The basic units of practically all power trains are gears. Gears are a means of supplying twisting force to rotating parts. This unit will introduce basic gear configuration and styles, and will explain the basic functions of power trains used in homes and industries.

Belt drives are also a common form of power transmission in industry today. Many types of belts are used, each with its own advantages. By studying this unit, you will learn about common home and industrial uses of belts and pulleys.

This unit will be divided into three parts, one on each type of transmission system listed.

Procedure

You should read the material provided and look at the samples of various transmission devices provided by your instructor. Answer the questions in the written text and then conduct the gear experiment as described. Complete the worksheet as you work through the experiment.

Chain Drives

Chain drives are an important type of power *transmission* systems. Chain drives are a series of links joined together by a variety of means which provide a flexible hinged joint. The center distance from one hinge point to the next is called the *pitch*. This is the main identification factor of *chains*. Other identification factors are chain width, roller diameter, construction design, and material used in the *links* (see fig. 1). Chain drives are quite similar to belt drives except that they are more powerful while being somewhat less flexible. Chain drives consist of an endless chain plus one or more *sprockets*.

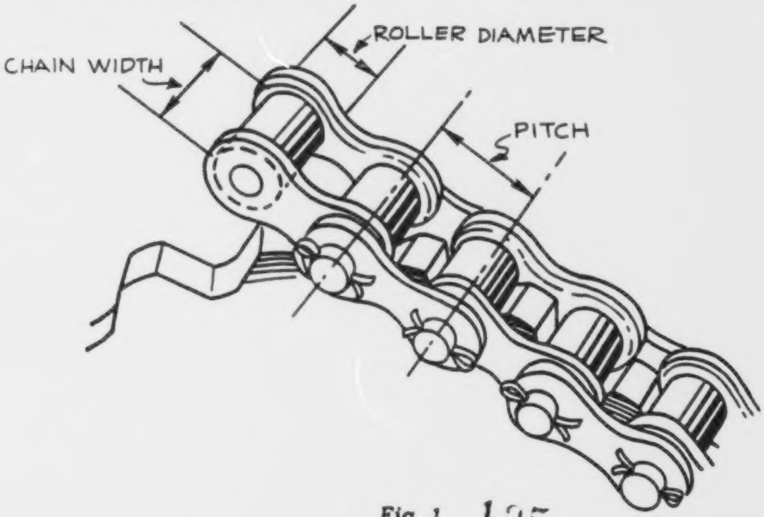
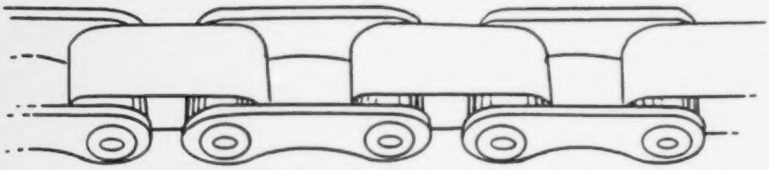


Fig. 1.

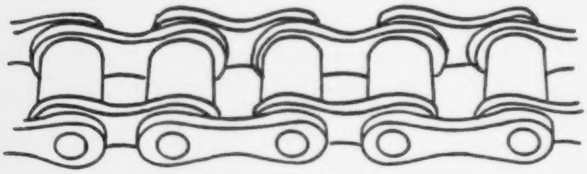
The three basic uses of chain drives are transmitting power, converting motion, and timing (synchronization). Chain drives are used as flexible gearing in transmitting power. They transmit *torque* from one rotating shaft to another. Chain drives convert motion by carrying, pulling, pushing, or sliding. Chain drives are used in timing action by synchronizing movement, such as timing valves in an engine.

> Chain drives are similar to belt drives except that they are (1)____________ and ______________. Chain drives consist of an endless (2)____________. Chain drives transmit (3)_______________ from one rotating shaft to another.

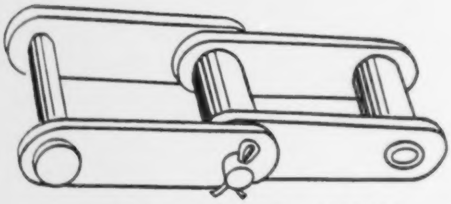
There are many types of chains. The major types are block, detachable link, pintle, roller, rollerless, and silent (see fig. 2).



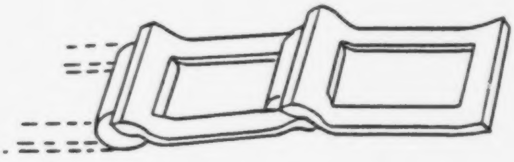
BLOCK CHAIN



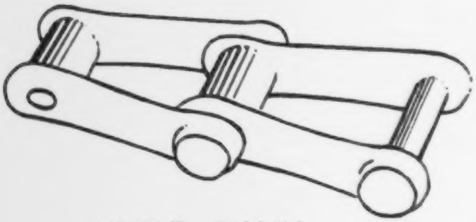
ROLLER CHAIN



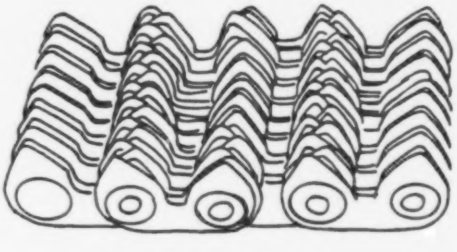
ROLLERLESS CHAIN



DETACHABLE LINK CHAIN



PINTLE CHAIN



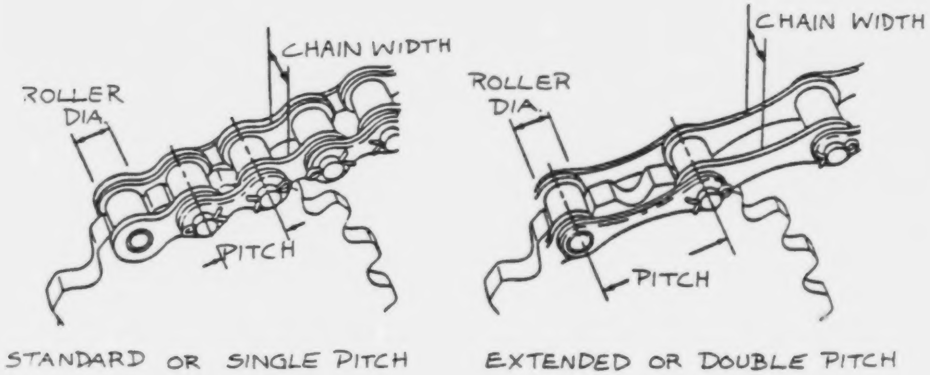
SILENT CHAIN

Fig. 2.

Block chains are used for conveying small items. They consist of a series of cast blocks joined by side bars and pins. *Detachable link chains* are simple chains used for slower speeds and light loads. The links are cast iron or steel. One end is formed like a hook while the other end is a bar. They lock end to end this way. *Pintle chains* are used in slow movement conditions and where exposure to weather and abrasive materials is a factor. This type of chain is composed of a series of malleable iron links joined by pins.

> Block chains are used for conveying (4)____________ items. Detachable link chains are used for (5)__________ speeds. Pintle chains are used where exposure to (6)______________ and abrasives is a factor.

Roller chains are used for moderate speed conditions and where average wear and heavy loads are factors. The standard chain consists of alternate roller links and pin links. The links are comprised of two side bars and two pins. Double-pitch roller chains have the same parts as the standard-pitch chain. The difference between them is that the side plates are twice as long in the double-pitch chain. Double-pitch roller chains are used for drives with lower speeds and lower horsepower. Another variation of the standard roller chain is the offset roller chain. This type of chain is used to connect the chains where an odd number of links is to be used. Another variation of the basic roller chain is that they are made in double, triple, and multiple strand series. Elements in roller chain size selection are pitch, width, and roller diameter. These factors determine a standard number which is assigned to a particular roller chain (see fig. 3).



STANDARD OR SINGLE PITCH

EXTENDED OR DOUBLE PITCH

Fig. 3.

> A standard roller chain consists of alternate (7)_________ links and (8)____________ links. The difference between a standard roller chain and a double-pitch roller chain is that the latter has side plates which are (9)___________ as long as the former. Elements in roller chain (10)___________ are pitch, width, and roller diameter.

Rollerless chains are used for low-speed conditions and where chain wear is not a particularly important factor. The links in this chain consist of one-piece cast links which are fastened with side bars and pins. *Silent chains* are used for high-speed conditions over 1,350 meters per minute with very little noise or vibration. An example would be for valve timing in automobile engines. This type of chain consists of flat metal links with a tooth shape at each end. The links are fastened by pins. This chain operates more smoothly with less noise because of the way in which the teeth of the link plates engage the mating teeth of the sprocket, which is similar in appearance and design to a gear (see fig. 4).

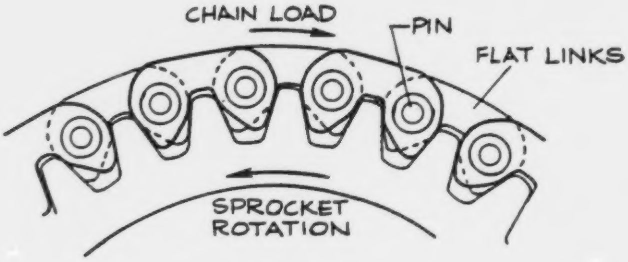


Fig. 4.

If chain wear is not a particularly important factor, a (11)________________ chain might be used. (12)______________________ chains are selected for high-speed conditions with very little (13)_________ or (14)_____________.

The sprockets in chain drives must exert force on the chain or transfer the pull of the chain in to rotary motion. To do these things, it is important that the chain *meshes* properly with the sprocket teeth. Two critical dimensions determine the size or pattern number of the sprocket: the width and the pitch. The width of the sprocket should permit clearance between the side bars of the chain. Other factors to be considered are the number of teeth, materials, design of the body, design of the *hub*, and other special considerations. Body design can be solid, webbed, or spoked. Generally speaking, small diameters are for spoked hubs. Hub designs are generally divided into three types:

- Type A hubs have no hub projections and are commonly used for general service in the small to medium diameter and capacity range.
- Type B hubs have one hub projection and have a straight finished bore, usually with a key and a setscrew.
- Type C hubs have a hub projection on each side and are used for large sprockets. They also usually have a straight finished bore and have a key and setscrew.

In addition to these types of sprockets, there are variations which are used for specific purposes (see fig. 5).

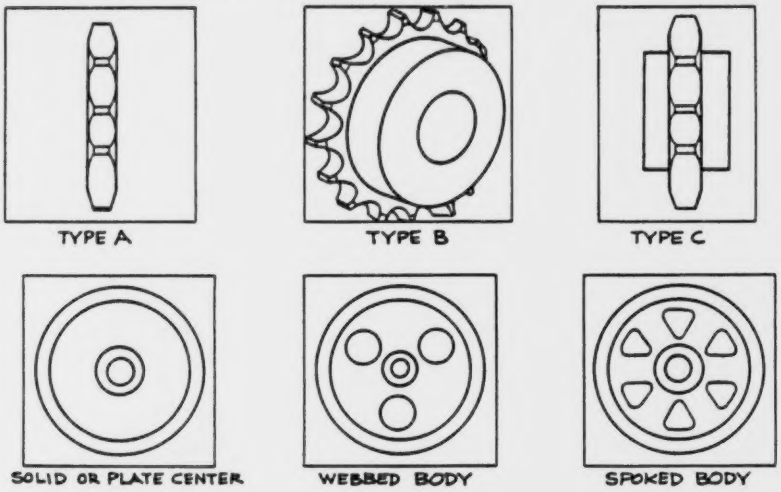


Fig. 5.

The critical dimensions of a sprocket are the (15)________________ and (16)________________. Body design of sprockets may be (17)________________, webbed, or spoked. Hub types are (18)________________, (19)________________________, and (20)________________.

Correct use of chain drives is very important. Some factors in chain drive life are correct direction of travel, proper location of belt tightener, correct matching of chains and sprockets, proper starting and stopping procedure, correct alignment of shafts and sprockets, proper installation and detachment procedures, correct amount of slack, proper cleaning of parts, proper storage procedures, and proper lubrication procedures.

Chain drives should rotate in the proper (21)________________. The belt tightener must be located in the (22)________________ place. Chains and sprockets must be properly (23)________________.

Some advantages of chain drives in contrast to belt drives are that they do not slip or creep, they maintain a positive speed ratio between the driving and driven parts, they are somewhat more compact, they can operate at higher temperatures, they require less adjustment, and there is not deterioration due to age, oil, and sunlight. Some disadvantages in this comparison would be that they are somewhat noisy, they require frequent lubrication, and they must be aligned more carefully.

An advantage of a chain drive in contrast to a belt drive is that they do not (24)__________ or creep. A disadvantage in this comparison is that chain drives require more frequent (25)________________.

Gear Drives

Gear drives were one of the earliest forms of power transmission, and they are the most common way to transmit power today. They are used in both open and closed housings. *Gears* provide a positive drive with no slippage. They can be used to provide change of direction, change of speed and force, on-off switching, or a

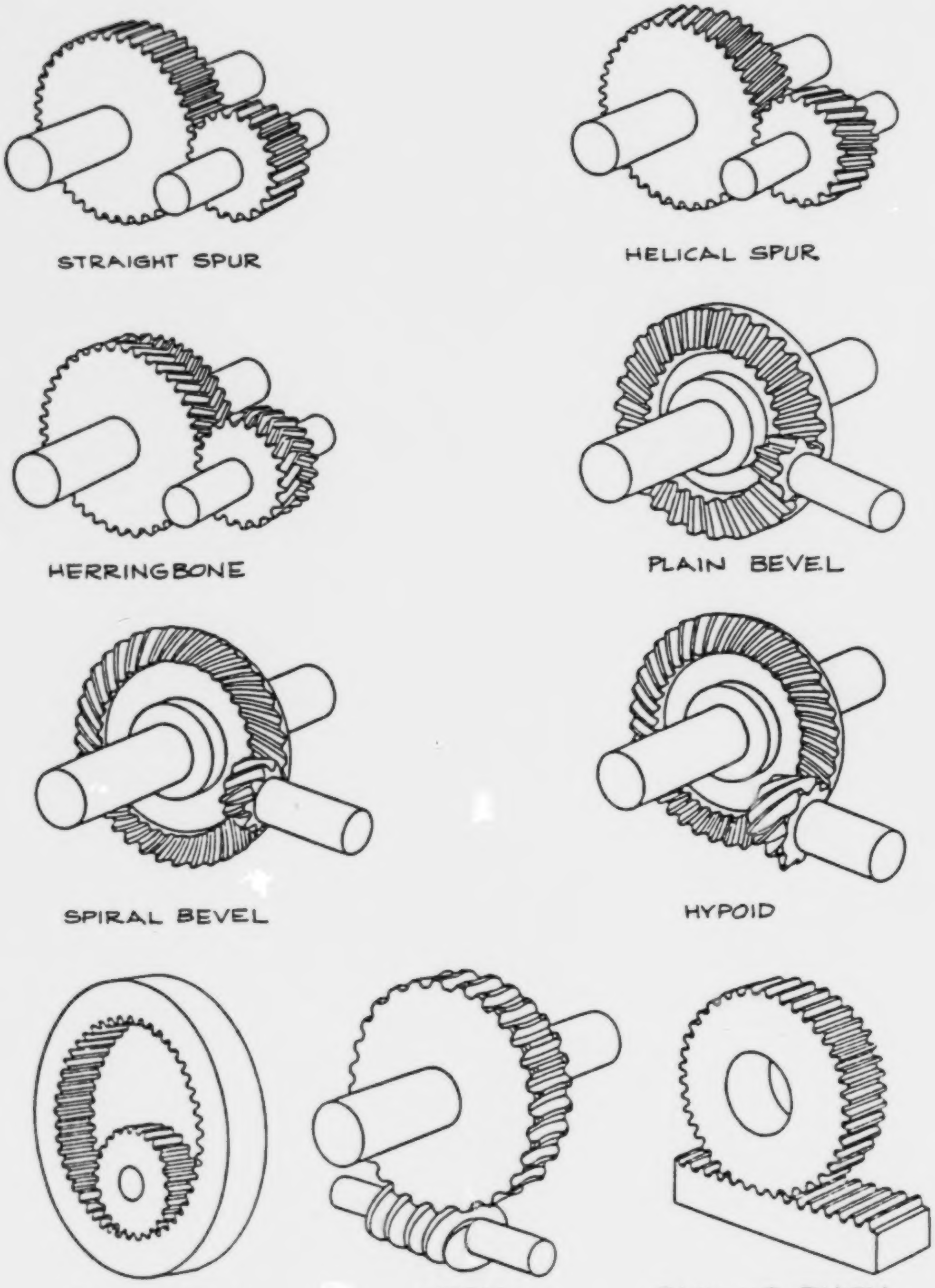

STRAIGHT SPUR
HELICAL SPUR
HERRINGBONE
PLAIN BEVEL
SPIRAL BEVEL
HYPOID
PLANETARY
WORM
RACK AND PINION

Fig. 6.

combination of these. A series of gears called a *gear train* can be assembled to accomplish various tasks such as direction, speed, and torque changes. Gears provide a method of applying twisting force (torque) to rotating parts. A small gear will drive a larger gear at a reduced speed but with much more torque, in contrast to a large gear driving a smaller gear at a fast speed but with low torque. Gear ratio is a measure of speed and torque changes in the *power train.* Gears may be constructed of cast iron, alloy, bronze, brass, aluminum, a variety of other metals with special characteristics, and plastic.

> The most common way to transmit power today is by using (1)__________.
> One function of gears is to supply change of (2)____________________
> as well as change of speed and (3)________________________.
> A small gear will drive a larger gear at (4)____________________
> with an increase in (5)______________________________.

Gears are usually classified by the type of teeth they have plus the type of surface on which the teeth are cut. The major types of gear teeth cuts are straight and helical. There are several types of gears, with the common types being spur, helical, bevel and miter, herringbone, and worm (see fig. 6).

Spur gears have the most simple type of gear design. The shafts of these gears are in the same plane and are parallel. The teeth are cut straight and are parallel to the axis of the shaft. Usually, mating gears have one or two pairs of teeth in mesh at all times. This type of gear is somewhat noisy; therefore, it is used at slow speed. An example of where these gears are used would be sliding gear transmissions.

Helical gears are somewhat like spur gears with the difference being that the teeth are cut at an angle across the perimeter of the gear instead of being straight. This provides a larger contact area for the teeth, which results in greater strength and capacity. The weakness with helical gears in contrast to the straight spur gear is that they produce *side thrusts* or forces that increase the wear on the bearings. Helical gears are also used in transmissions. *Herringbone gears* are double helical gears which have teeth angled in opposite directions to produce balanced thrusts.

> Spur gear teeth are cut (6)______________________________
> across the perimeter of the gear. Helical gear teeth are cut at an (7)____________ across the perimeter of the gear. Herringbone gears are (8)____________ helical gears.

Bevel gears transmit power between shafts intersecting at 90 degrees. They allow the flow of power to turn a corner. They are connected by teeth which are cone-shaped. The teeth are narrow and tapered on the inside and somewhat wider on the outside of the gear. If the teeth are cut straight on a line with the shaft, they are plain bevel gears. If the teeth are cut at an angle with the faces of the gear, they are spiral bevel gears. Bevel gears are used in slow-speed situations, and spiral bevel gears are used where higher speeds and strength are required.

> Bevel gears allow the power to (9)___________ a corner. The difference between plain bevel gears and spiral bevel gears is the (10)_____________ of the teeth.

Worm gears are used on nonintersecting shafts at 90 degrees. The driver is called the worm, and the worm gear is the driven part. The worm acts somewhat like a screw, and drives the worm gear in a sliding type of action. This type of gear has a high mechanical advantage because each time the work gear rotates on revolution, the helical gear will move one tooth. *Rack-and-pinion* gears provide a special type of gear arrangement which transfers straight-line motion into rotary motion or rotary motion into straight-line motion. This gear arrangement uses a spur gear and a flat bar with straight-sided teeth cut into its surface. The spur gear is the pinion, and the bar is the rack in this arrangement. Another special type of gear is the *planetary* system. These gears basically operate like our solar system.

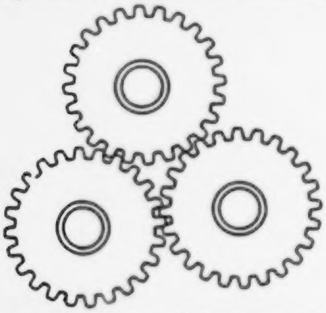
Gears are subject to failure if they are not adequately lubricated. Also, they are subject to backlash or endplay. Alignment and fit are important elements of gear care. Care must be taken in installing gears as well as in not overloading them. Periodic inspection of gears is an important part of gear maintenance.

Worm gears are used on (11)__________ shafts at 90 degrees. Rack-and-pinion gears can transfer straight-line motion into (12)__________ motion. Gears are subject to (13)______________ if they are not properly lubricated.

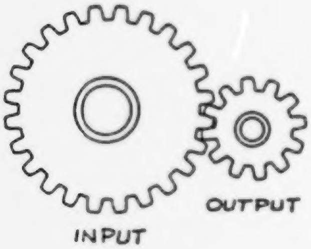
Gear Combination Experiment

Study the following illustrations. Determine what the drive is doing, and answer the questions.

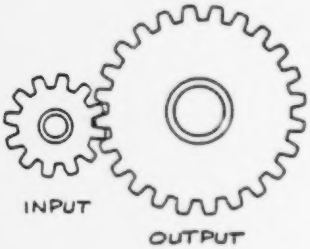
1. Does this gear layout increase distance or torque? (14)________________
   Why?



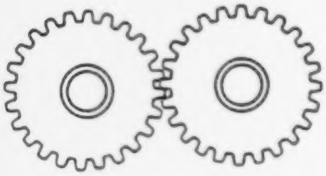
2. Does this gear layout increase distance or torque? (15)________________
   Why?



3. What control does this gear layout accomplish? (16)________________
   Why?



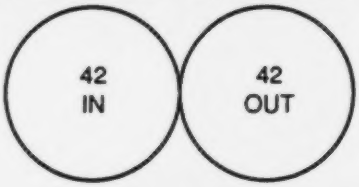
4. What control is accomplished by this gear layout? (17)________________
   Why?



You will need the following supplies:
- Mounting board
- 42-teeth gears (2)
- 31-teeth gears (2)

Get the supplies listed above from the storage area or your teacher. Observe the board closely, and you will see several shafts protruding from the board and circles drawn around these shafts. The size of the circle indicates which size gear is to be placed on each shaft. Also note that the different combinations of gears are numbered from 1 to 5 in the instructions. These numbers will correspond to a particular experiment.

1. Using the gear mounting board, set up combination number one using the two (2) 42-teeth gears. Rotate the input gear one revolution clockwise.



Combination 1

(18) What do you observe about the rotation of the output gear? ________
(19) How many revolutions does the output gear make for each turn of the input gear? ______________ Draw arrows on the diagram of the gear combination to indicate which way each gear turns.

2. Gears must have teeth that are matched or *mesh* (which means that they will work together). However, the diameter of these gears may be of many different diameters and number of teeth. There is an equation which expresses the relationship of teeth to the number of turns for a given set of gears. The formula is

$T \cdot N = t \cdot n$ where:
T = teeth on the driver gear
N = turns of the driver gear
t = teeth on the driven gear
n = teeth on the driven gear

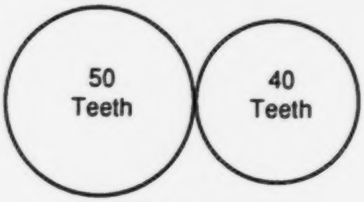


Fig. 7.

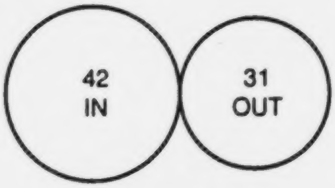
Figure 7 shows a driver gear with 50 teeth and a driven gear with 40 teeth. How many revolutions will the driven gear make for each revolution of the driver gear? Remember that $T \cdot N = t \cdot n$

Transpose $n = \frac{TN}{t}$ given: driver (T) = 50 teeth
driver (N) = 1
driven (t) = 40 teeth
$n = \frac{50 \bullet 1}{40}$ driven (n) = n (unknown)

$n = \frac{50}{40} = 1.25$ turns

This tells us that the driven gear will turn one and one-fourth times for each turn of the driver gear.

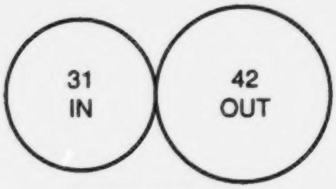
Now set up combination 2. This will be the 42-teeth gear as the driver and the 31-teeth gear as the driven gear.



Combination 2

(20) Which direction does the driven gear turn when the driver gear is turned clockwise?__________ (21) This combination of gears increases __________________________ (speed or force). (22) Based upon the previous equation, $T \cdot N = t \cdot n$, how many revolutions does the driven gear make for each revolution of the driver gear?________________________

3. Set up gear combination 3. This will be the 31-teeth gear as the driver and the 42-teeth gear as the driven gear.

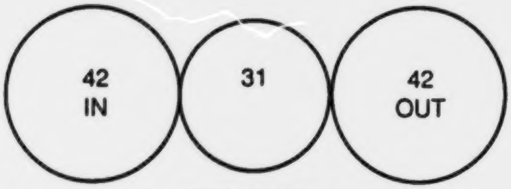


Combination 3

(23) Which direction does the driven gear turn when the driver gear is turned counterclockwise?________________________ (24) This combination of gears increases ________________________________ (speed or force). (25) Based upon the previous equation, $T \cdot N = t \cdot n$, how many revolutions will the driven gear turn for each revolution of the driver gear?

____

4. Set up gear combination 4. This combination consists of a 42-teeth driver gear, a 31-teeth gear in the middle, and a 42-teeth driven gear.

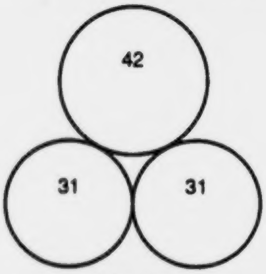


Combination 4

Rotate the driver gear in a clockwise direction. The middle gear rotates in a (26)_______________ direction, while the driven or output gear rotates in a (27)_______________ direction. From your observation of this gear combination, the output from an even number of gears is (28)___________ the input, while an odd number of gars will have an output that is the (29)_______________ as the input.

Using the formula, the revolution of the middle gear will be (30)_________ for each revolution of the input gear. The revolutions of the output gear will be (31)_______ for each revolution of the large driver gear. (32) By rotating the driver gear one revolution, how many revolutions will the output gear turn if it has 64 teeth?_______________________________

5. (33) Before setting up combination 5, can you predict the direction of the two 31-teeth gears if the 42-teeth gear is rotated counterclockwise? ______________________ Now rotate the 42-teeth gear counterclockwise to verify your answer. (34) Did you predict accurately? _______________________ (35) What was the final result?__________

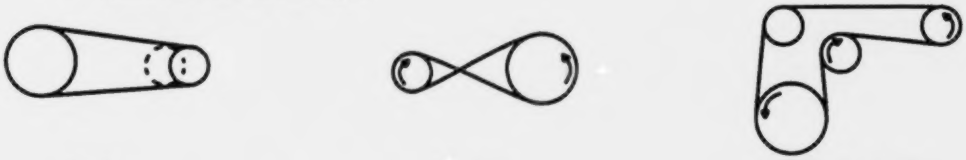


Combination 5

Belts and Pulleys

The purpose of *belts* and *pulleys* is to transmit power. This power is transmitted by frictional contact between the belt and the driving pulley. Another purpose of belts and pulleys is to provide for three controls (see fig. 8):

1. on/off switching
2. directional changes
3. speed and force changes



On-Off

Reverse

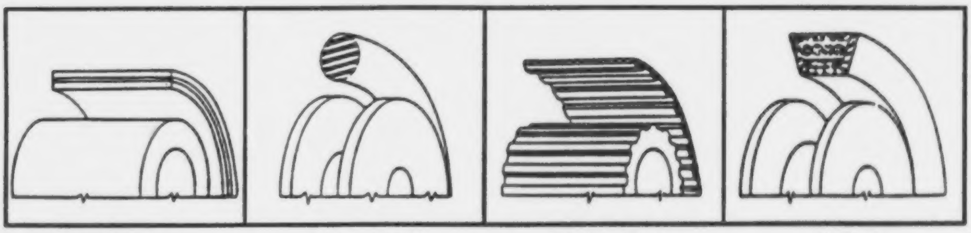
Directional Change

Fig. 8.

The purpose of belts and pulleys is to transmit (1)______________. Belts and pulleys provide for (2)________________ (how many) control functions.

The ability of a belt to transmit power depends on several factors:
1. the amount of frictional contact
2. the tension on the belt
3. the angle of wrap (sometimes called the arc of contact) of the belt and pulley
4. the speed of the belt

There are several major types of belts used today, including flat, round, timing, and V-belts (see fig. 9).



Flat Belt Round Belt Timing Belt V-Belt

Fig. 9.

Round belts are ordinarily used for relatively light loads, such as sewing machines, phonographs, and tape players. On occasion, they can be used for heavier purposes. They are made of solid rubber or rubber with cords inserted for extra strength.

Flat belts were one of the earliest items used in power transmission. They are not used a great deal today. Their common use was in drives where much power was needed to drive machines which were widely separated. Also, they are still used on conveyors as a moving surface for carrying material. Flat belts are made of leather, rubberized fabrics and cords, or woven fabrics and synthetic materials. Some advantages of flat belts are their simplicity, strength, relatively low original cost, and good dust resistance. Disadvantages are the large amount of space they require and their inflexibility.

(3)______________ belts are usually used for relatively light loads.
(4)______________ belts were one of the earliest forms of belts.

V-belts are the most commonly used method of belt-driving loads. This is due to the wedging action of the belt against the sides of the pulley groove which results in greater effectiveness. V-belts have several advantages that make them very popular today. The wedging action allows a smaller amount of wrap on a small pulley and a large speed ratio. Also, a more compact drive can be used. V-belts absorb shocks so that motors and bearings last longer. They run quietly and with a small amount of vibration. Finally, efficiency of power transmission is very high.

The (5)____________ action of the V-belt results in good efficiency of the belt. An advantage of using a V-belt is that it will absorb (6)____________________ quite well.

Although V-belts are made in several types, they are all made up of four basic sections: the top, center, bottom, and cover. The top part is the tension section. It is made of rubber so that it can stretch as the belt goes around the pulley. The center part is where the tensile strength is obtained by using cords that do not compress or stretch. The bottom part is the compression part because it becomes compressed as it goes around the pulley. The cover part is made of tough fabrics and rubber, which protects the inside section (see fig. 10).

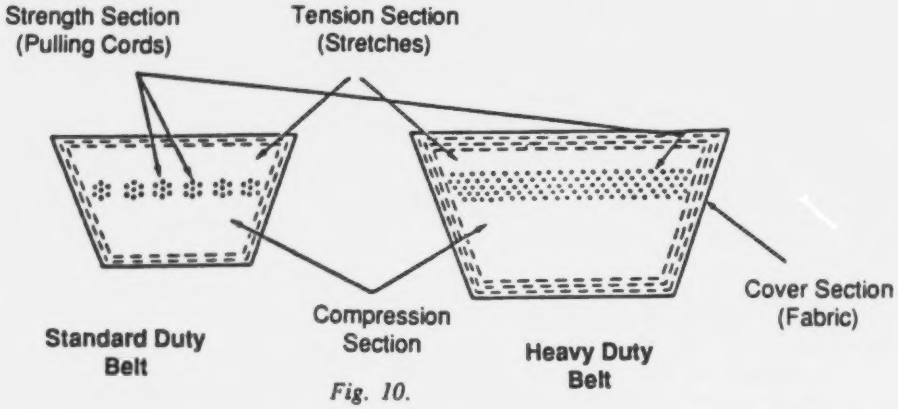

Strength Section
(Pulling Cords)
Tension Section
(Stretches)
Cover Section
(Fabric)
Standard Duty
Belt
Compression
Section
Heavy Duty
Belt

Fig. 10.

The top part of a V-belt is called the (7)__________ section. The bottom part is called the (8)__________ section.

There are several variations of the common V-belt. One of these is called the double-angle V-belt (see fig. 11). Another version is the banded V-belt. This type is a multiple belt fastened to a tie band by vulcanizing (see fig. 12).

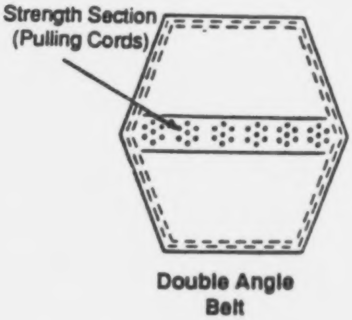

Strength Section
(Pulling Cords)
Double Angle
Belt

Fig. 11.

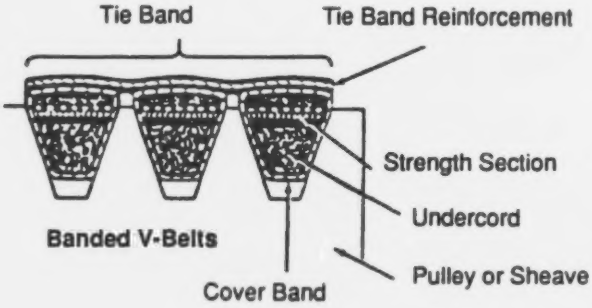
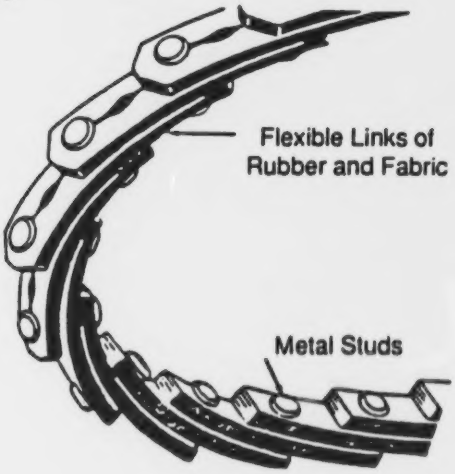

Tie Band
Tie Band Reinforcement
Strength Section
Undercord
Banded V-Belts
Pulley or Sheave
Cover Band

Fig. 12.

Another type is the link-type V-belt. This type is used in multiple-belt drives where it would be hard to match the length of each belt. Links can be added or subtracted to change the belt length to correspond to the drive application. The links consist of small, precision-shaped segments which are die-cut from rubber-reinforced layers of fabric (see fig. 13).



Linked V-Belts

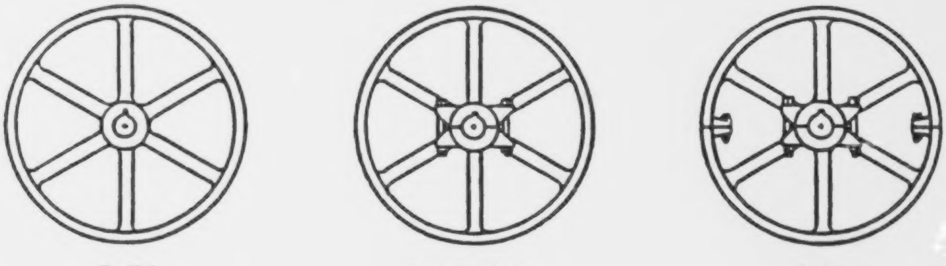
Fig. 13.

Timing belts are basically flat belts with teeth which are equally spaced on the inside surface. These teeth come in contact with a toothed pulley. The load-carrying elements of this belt consist of continuous, helical wound steel cables embedded in the belt. There is no slippage with these belts, and they are quite efficient. The teeth are rigid with lengthwise flexibility that reduces stretching. They provide for a wide range of load and speed and produce little heat or noise.

> Timing belts have (9)________________ which are equally spaced. The teeth in timing belts come in contact with a toothed (10)__________________.

Each type of belt requires a special pulley or sheave (note that the terms *pulley* and *sheave* mean the same thing). Flat transmission belt pulleys are available in materials such as cast iron, steel, combination steel and cast iron, wood, and paper. Pulley types are solid, clamp hub, and split (see fig. 14).

STANDARD PULLEY TYPES



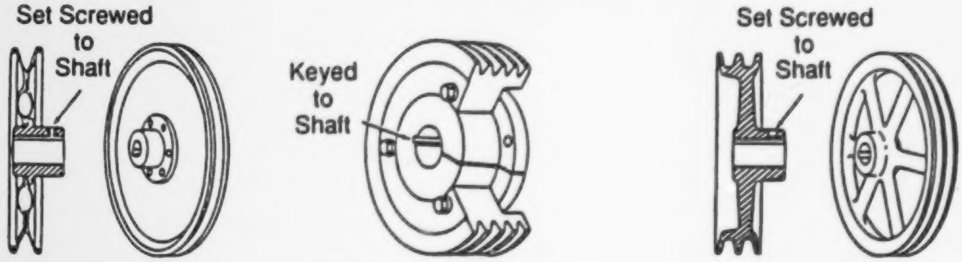
Solid **Clamp Hub** **Split**

Fig. 14.

Another name for pulleys is (11)________________. Flat belt pulleys are made in solid, clamp hub, and (12)________________ types.

V-belts pulleys are commonly available in formed steel or cast iron. Sometimes they are made of aluminum alloy, plastic, or die-cast metal. Pulleys which are standard are made with either regular or deep grooves. A deep-groove pulley is generally used whenever belt stability is a factor or whenever the V-belt enters the pulley at some angle, such as a quarter-turn drive on vertical shaft drives. Usually, formed steel pulleys have a hub that is formed as one piece with the pulley. Multiple-V pulleys may be made to fit various shaft sizes. These may have the bushings formed as part of the pulley or as a part which is interchangeable. Pulleys are usually aligned on the shaft using a key. To lock them in place, they are fastened with either a setscrew or lockwasher and hex nut (see fig. 15).

BELTS AND PULLEYS



Spoke Cast Sheave with Integral Hub

Disk Type Cast Sheave with Remote Hub

Formed Steel Light Duty Sheave with Integral Hub

Fig. 15.

Evaluation

Your teacher will grade the worksheet you complete, and may observe your work as you conduct the experiments.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 14
(1-2 DAYS)

MAGNETISM

Essential Elements: 75.50(f): 8, 9
TAAS Objectives: English Language Arts 2, 4, 5

Activity Overview

The student will conduct an experiment to see what happens when a magnetic field passes through a coil of wire, what factors affect the output of a generator, and what external forces must be applied to a generator to produce electricity.

Challenge Statement

Electricity is very important in our society and throughout the world. Regardless of the fuel used to run electrical generators, the process that actually produces the electricity is basically the same.

Systems Model

Resources
Wires, magnets, energy input

Processes
Relative motion between coil of wire and magnetic field

Applications
Generators for electricity

Impact
Environmental: Wastes and pollution from input fuels, magnetic fields surrounding power lines, transmission systems
Social: Improvement in standard of living in countries with readily available electrical power

Interfacing with Other Disciplines

Science: Electricity, magnetism, energy (fuel) supplies
Social Studies: Social effects of readily available electrical power, effects on environment

Critical Thinking Skills Reinforced

Students will understand the process of producing electricity with magnetism, and recognize and state the effects of variations in the process on the outcome.

Teaching Tips

1. Encourage the student to systematically perform each step and record the same type of information for each result. This will help the student to compare and contrast the results of different steps.
2. The activity may be done individually or in small groups, depending on the amount of equipment available.
3. Explain the function of a galvanometer to the students prior to the lab activity, including such factors as what a galvanometer measures, direction of needle deflection, and the amount of deflection. An understanding of the function of the measurement devices is necessary to

translate the actual observed deflections into an understanding that electricity is produced and flowing.

Instructional Strategy

Encourage feedback from students during the activity. For example, you might ask a question such as "I see that the needle moved a different direction on steps ______________________ and ______________________. What caused the difference?"

Equipment/Supplies

1. Zero center galvanometer
2. One coil of insulated copper wire (5 turns)
3. One coil of insulated copper wire (10 turns)
4. One strong magnet
5. One weak magnet

Evaluation Key

1. Check the student lab report sheets for accuracy.
2. Check answers to questions.

Support Materials

1. Bohn, R.C., and MacDonald, A.J. *Power: Mechanics of Energy Control.* 2nd ed. Bloomington, Ill.: McKnight, 1983.
2. Duffy, J.W. *Power: Prime Mover of Technology.* Bloomington, Ill.: McKnight, 1972.
3. Matt, S.R. *Electricity and Basic Electronics.* South Holland, Ill.: Goodheart-Willcox, 1977.
4. Miller, R., and Culpepper, F. *Energy: Electricity/Electronics.* Cincinnati: South-Western, 1982.

Modifications for Handicapped, Disadvantaged, and LEP Students

Students with limited reading, writing, or English proficiency will probably need assistance in interpreting the procedure instructions and recording the data. Students with physical limitations may also need assistance in manipulating the coil and magnet as directed.

MAGNETISM

Learn about how magnetism is used to produce electricity, and about factors that affect the flow of electricity and the amount of electricity produced.

Challenge Statement

Electricity is very important in our society and throughout the world. Several types of electrical generating plants are in use in the world today, including nuclear-powered plants, coal-fired plants, natural gas-fired plants, and hydroelectric plants. Regardless of the type of energy used to run the electrical generator, the process used to actually produce the electricity is basically the same.

The generation of electricity is necessary if we are to use machines, lights, appliances, and heating and cooling equipment. After the discovery that electricity could be produced using *magnetism*, machines called *generators* were designed and built. They produce electricity which flows in one direction in a circuit (called *direct current*). Technologists have also developed a device (called an *alternator*) used to produce *alternating current* electricity, which is the main type of electricity used in our country for homes and industries.

Objectives

- To explain the process for producing electricity from magnetism
- To demonstrate the production of electricity with magnetism
- To explain alternating current and direct current
- To list factors that determine the amount of electricity produced
- To demonstrate how to reverse the current in a circuit
- To name a device that is used to produce electricity using magnetism

Vocabulary/Concepts Reinforced

- Magnet
- Magnetic field
- Generator
- Galvanometer
- Alternating current
- Direct current
- Coil
- Electricity

Equipment/Supplies

- Zero center galvanometer
- One coil of insulated copper wire (5 turns)
- One coil of insulated copper wire (10 turns)
- One strong magnet
- One weak magnet

Introduction

Long ago, it was discovered that electricity could be produced from magnetism. The process requires movement between a wire or *coil* of wire and the invisible *magnetic field* around a magnet. In this activity, you will demonstrate, using a galvanometer, the production of electricity with magnetism. While you are observing the results, look for the factors that make the needle move in different directions and different amounts. Remember that the galvanometer is a tool used to measure the amount and direction of electricity.

Procedure

1. Use equipment provided by the instructor.
2. Connect the coil containing 5 turns of wire to the galvanometer.
3. Select the weak magnet, and mark one end of the magnet with a small piece of masking tape.
4. Insert the marked end of the magnet into the coil.
5. Observe and record the direction the needle of the galvanometer moves.
6. Remove the magnet, and observe the needle deflection.
7. Insert the unmarked end of the magnet into the coil. Observe the needle direction and deflection when the magnet is removed.
8. Insert the magnet into the coil and leave it there. Once the needle is at rest, record the direction in which the needle points.
9. Pick up the magnet, but leave it in the coil of wire. Hold the magnet still, and move the coil of wire up and down the length of the magnet. Record your results.
10. Push the magnet in and out of the coil of wire, and observe the needle direction.
11. Remove the coil of wire with 5 turns, and replace it with the coil of wire with 10 turns. Repeat steps 2 through 10 with the coil of wire with 10 turns.
12. Select the strong magnet. Repeat some of the steps and compare the results with those from the weak magnet.
13. Compare the results, looking at such items as movement vs. nonmovement, number of coils of wire, and strength of the magnet.

Evaluation

As you perform the activity, you should record your results on the form provided. After the activity, answer the questions listed.

Lab Activity Report

Magnet	Coil	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10
A	5 turns						
	10 turns						
B	10 turns						

Questions

1. Does the galvanometer needle behave differently when the coil or magnet are moving and when they are not moving with respect to each other?

2. Was there a difference in the results from the 5-turn coil and the 10-turn coil? If so, what difference?

3. Why was a galvanometer used in the activity?

4. Describe what is meant by the term *alternating current*, in your own words. Were you able to produce alternating current in your activity?

5. What factors seem to affect the output of electricity?

6. How do you think the standard of living in a country which has electricity readily available compare with that in a country without electricity available to its citizens?

7. It may seem that you are producing electricity without supplying any energy to the process, although you actually are supplying energy. What energy source are you providing?

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 15
(6-7 DAYS)

FROM WAGONWAY TO MAG-LEV

Essential Elements: 75.50(b): 2C, 2D, 3A, 6B, 6D, 6E, 7A, 7B, 8A, 8B
75.50(f): 1, 2, 4, 6, 9, 10, 12, 17
TAAS Objectives: Language Arts: RC 1-5; WC 1-3
Mathematics: PS 3

Activity Overview

This unit is designed to look at the building blocks of rail transportation. Your students will see the relationship between the inventions of the past and the innovations of the future.

Challenge Statement

New technology grows from past technology. Do you think early humans could envision the wagon as they rounded the first wheel? Richard Trevithick had no reference for mag-lev transportation when he invented the first steam locomotive in 1804. Our present technology acts as building blocks for inventions of the future.

Although mag-lev transportation is a reality in some parts of the world, we are still trying to overcome some challenges to make it a workable solution to our mass transportation problems in the United States.

Systems Model

Resources

Students as historians, designers, engineers, and marketing personnel
Instructor as historian, train engineer, discussion leader, monitor, and evaluator
Model train
CADD system
Drawing and advertising supplies

Processes

Reading and discussion of historic information
Brainstorming technological building blocks
Observing a traditional train
Listing advantages and disadvantages of rail system and mag-lev system
Sketching and designing a mag-lev system
Designing advertising
Evaluating mag-lev sketches and advertisements

Applications

Scientific discoveries to technological innovations
Historic observations to present and future trends
Reading and discussion skills to technology knowledge base
Creative design to mag-lev system
Evaluation process to advertising

Impact
Career choices
Technological literacy
Transportation systems
Integration of science, math, social studies, and technology

Interfacing with Other Disciplines

Language Arts:	Students will learn new vocabulary and concepts. They will read and discuss historic information and record information in writing.
Mathematics:	Students will understand the impact of speed on a transportation system.
Science:	Students will understand the relationship between scientific principles and technological innovations.
Social Studies:	Students will study the history of the railroads and relate it to current and future trends.

Critical Thinking Skills Reinforced

Students will demonstrate an understanding of the building blocks of technology by transferring their knowledge of the railways to other technological developments. They will distinguish between traditional rail systems and mag-lev vehicles. They will design a mag-lev system appropriate to their area and formulate a marketing program to go along with it.

Teaching Tips

1. This unit can be as simple or complex as you would like to make it. If you feel your students can build their own mag-lev vehicle, and you have the resources, the instructions are in an article titled "Demystifying Mag-Lev," in the March/April 1991 issue of *Ties Magazine*. You can purchase a demonstration kit for about $400 by contacting:
   Mr. Gary Bolyard, Coordinator
   Fairmont State College
   Technology Education Program
   Locust Avenue
   Fairmont, West Virginia 26554
2. If you have a number of classes participating in this activity, ask the social studies teacher to allow her/his students to judge the best mag-lev advertisements. Which ad would catch the eye and interest them in trying a new type of transportation?
3. The language arts classes could submit slogans for the drawings.
4. The art classes could take the computer drawings and make renderings for a school wide display with the ads included.

Instructional Strategy

- Open the class with a historic review of the railroad.
- Challenge the students to identify several technological products that have become building blocks for new products or concepts.
- Monitor the students as they design their mag-lev vehicles and advertisements.
- Close the class with an evaluation of the creative designs of your students.

Equipment/Supplies

1. A model electric train
2. CADD if available
3. Drafting paper and pencils
4. Drawing paper and colored markers

Evaluation Key

1. Grade your students on the Advantage/Disadvantage Worksheet.
2. Grade them on the neatness and creativity of their drawing or advertisement.

Support Materials

1. Encyclopedia
2. Current technology publications
3. Ruiz, E., et al., "Demystifying Mag-Lev," *Ties Magazine*. March/April 1991.

Name________________________________

Advantage/Disadvantage Worksheet

RAILROADS **MAG-LEV**

Advantages **Advantages**

1. ____
____
2. ____
____
3. ____
____
4. ____
____
5. ____
____
6. ____
____

Disadvantages **Disadvantages**

1. ____
____
2. ____
____
3. ____
____
4. ____
____
5. ____
____

FROM WAGONWAY TO MAG-LEV

Study the building blocks of rail transportation.

Challenge Statement

New technology grows from past technology. Do you think early humans could envision the wagon as they rounded the first wheel? Richard Trevithick had no reference for mag-lev transportation when he invented the first steam locomotive in 1804. Our present technology acts as building blocks for inventions of the future.

Although mag-lev transportation is a reality in some parts of the world, we are still trying to overcome some challenges to make it a workable solution to our mass transportation problems in the United States.

Objectives

- To learn the history and automatic progression of rail transportation as it relates to developments in technology
- To understand the connection among technological developments in the past, present, and future
- To understand the principle behind mag-lev transportation
- To devise drawings and advertisements for a mag-lev system

Vocabulary/Concepts Reinforced

- Wagonway
- Steam engine
- Locomotive
- Amtrak trains
- Subway
- Diesel-electric
- Mag-lev train
- Magnetic attraction and repulsion
- Friction
- Linear induction electric motor (LIM)

Equipment/Supplies

- A model electric train
- CADD if available
- Drafting paper and pencils
- Drawing paper and colored markers

Introduction

Past and Present Rail Systems

Sometimes we get bored looking back over history, but in technology, history becomes a tool for inventions and building blocks of the future. We can look at different products that were developed to meet the needs of people at the time, and realize how much our needs have changed. A good example is in the movie *Back to the Future 3*, as Alec tries to live in all three time dimensions. Today's inventions and knowledge did not fit into the past, yet our time was not ready for technology of the future.

Let's step back in time and look at the beginning of railways. The first rail system was the wagonway or tramway, used during the 16th, 17th, and 18th centuries to transport minerals to rivers and ports in Scotland and England. In this simple system, wagons were mounted on rails and pulled by horses. Why did they use horses? Where do you think the term *horsepower* came from? Why did they mount the wagon on rails?

In 1804, after the invention of the steam engine, Richard Trevithick designed a steam engine, mounted it on wheels, put it on rails, and pulled 10 tons of iron, five wagons, and 70 men in Merthyr, Wales! They called it the locomotive. It was not a success. In 1828, the Baltimore and Ohio, the first railroad built in the United States, was chartered by the state of Maryland for the general transportation of passengers and freight. The first railroad for public transportation by locomotive was a short stretch of track built in South Carolina in 1829. This was the first railway built without a path down the middle for horses. How do you think locomotive transportation changed transportation for people and freight?

Most of the locomotives in operation today are diesel-electric. Diesel engines are used to turn generators that produce electricity for their electric motors. These trains are still carrying people and freight. Amtrak is the national passenger service subsidized by the government that uses diesel-electric locomotives. Why would the government subsidize a passenger railroad? Have you ever traveled by train? Why? What are some of the weaknesses in passenger services we have now? Why don't more people travel by rail?

Two other, widely used passenger rail services are commuter trains and subways. Commuter trains are used to transport people from the suburbs to the city in large metropolitan areas. Many of these trains are electric. Subways are above and below ground rail transportation in large cities. This system operates like bus services in smaller cities and towns. What would be the advantage of commuter trains and subways in large cities?

Present and Future Needs

For many years, the airlines met the needs of people traveling for fun or business. Now with crowded airports, inconvenient airport locations, increasing costs, and inflexible travel times, the need is changing. People want a fast and convenient system that will transport them between locations nonstop. Because of this, a high-speed **mag-lev** (magnetic levitation) vehicle was built in Japan, and a low-speed system was built in the United Kingdom. Two locations for a similar magnetic levitation train system have been proposed in the United States—one in southern California and one between Dallas and Houston.

As with any technology, there are both advantages and disadvantages. With 25 percent of the nation's energy consumption going towards transportation, fuel is a major consideration. Because the mag-lev system requires large amounts of electric current to produce the powerful electric fields, researchers have experimented with "stored energy" systems. The linear induction motor (LIM) is being studied for this purpose. It is a traditional rotating induction motor that can be laid out flat, changing the motion from rotary to straight line. This can offer a solution to the high energy concerns.

The major advantages of the mag-lev system are that the train operates quietly with almost no friction as it is magnetically levitated and does not touch the rails or guards. Because friction is reduced, less force is needed to start the train, and there is less wear and tear. A mag-lev train has fewer moving parts, requiring less maintenance and parts replacement than a conventional train. Because of the side guards, mag-lev trails are nearly impossible to derail. The mag-lev would provide a direct, nonstop, high-speed route between two cities, saving time and providing convenience.

Even with the strong advantages of the system, there are a number of restrictive disadvantages that need to be considered. The first is the initial cost of engineering, design, labor, and materials. As with any new rail system, miles of path must be cleared to put in the line. Many people have voiced a concern about the condition of the environment surrounding the line and the cost of restoring it. To balance the cost concern, construction and maintenance of the line would provide much needed jobs in a weak economy.

Two other concerns are in the actual function of the system. Curves in the track require a minimum radius of 4,000 yards and must be banked for the successful completion of a turn. It takes between one and two miles to stop a mag-lev traveling at 160 mph. How great do you see these concerns? Do you think these disadvantages are greater than the advantages?

How does a mag-lev vehicle work? Magnetic forces "float" the vehicle over a guide rail using the scientific principle of magnetic attraction and repulsion. Just as opposite poles of a magnet attract and like poles repel, the mag-lev vehicle is suspended in the air by opposing or attracting magnetic forces. A moving magnetic wave is created by a series of powerful electromagnets located along the guide rail, similar to the way waves carry a surfer over the ocean.

Procedure

1. After reading and discussing the Introduction, brainstorm other products or systems that have built off of inventions of the past. Start with the original scientific discovery or technological innovation, and identify as many inventions as you can that have brought us to the present.
2. Observe a simple model train. Fill in the Advantage/Disadvantage Worksheet. Discuss your ideas with the class. Turn in the worksheet to your instructor.
3. Study a map of your state. Where could a mag-lev vehicle be built to benefit the most people? How long would it be? Sketch your design of the mag-lev vehicle you would build.
4. Choose one of the two assignments.
   a. Formalize your mag-lev sketch. If you have a CADD system available, use it. Ask your instructor what standards you should use.
   b. Design a slogan and advertisement announcing the opening of the mag-lev system. You can use your sketch or wait for a formal sketch from one of your classmates. Be creative. Remember, like the locomotive, new ideas are not easily accepted. You will need to persuade your audience to change their transportation habits!
5. Share your ideas and drawings with the class. If there is more than one class participating in this activity, put together your best drawings and advertisements, and have your instructor present them to other classes.

Evaluation

1. You will be graded on your Advantage/Disadvantage Worksheet.
2. You will be graded on the neatness and creativity of your drawing or advertisement.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 16
(2 DAYS)

SUPERCONDUCTORS—WHAT'S EVERYONE SO EXCITED ABOUT?

Essential Elements:	75.50(b): 2C, 2D, 3A, 4A, 4B, 6A, 6B, 6D, 7A, 7B 75.50(f): 8, 9, 12
TAAS Objectives:	Language Arts: RC 1-6; WC 1-4 Mathematics: C 1, 2, 4; PS 1-4

Activity Overview

In this activity, you will conduct simple experiments with water to help your students understand the benefits of superconductors.

Challenge Statement

In most cases, electricity is transmitted over long distances from the power plant to our homes, schools, and businesses through wires. Because wires resist the flow of electricity, it must be transmitted at extremely high voltages to reach users. The voltage is reduced and divided at a substation, then stepped down again at a distribution station to be sent to pole transformers. The pole transformers reduce the voltage to between 480 volts (industry) and 240 volts (homes and businesses).

A generating station may start with 60,000 volts which ends up as 240 or 120 in our homes, schools, and offices. Although this system has worked for years, it is far from efficient.

Your students cannot realize the benefits of superconductors until they understand the limitations of our traditional transmission system. This activity is designed to help them understand the principle of electrical resistance.

Systems Model

Resources
Students as experiment observers, record keepers, and engineers
Instructor as experimenter, moderator, and resource person
Supplies necessary to conduct experiment

Processes
Manipulation of materials in experiment
Observation of results
Recording results of experiment
Plotting and evaluating results of experiment
Making deductions about results of experiment

Applications
Experimentation process to understanding of customary electric transmission
Understanding of customary electric transmission to benefits of superconductors
Math concepts to real-life situation

Impact
Innovative technology
Career choices

Interfacing with Other Disciplines

Language Arts: Students will learn new vocabulary and concepts. They will record results of experiments in written form.

Mathematics: Students will conduct an experiment that involves time and volume measurement. They will record the results of the experiment in chart form.

Science: Students will learn about new materials that are being developed through scientific research and experimentation. They will learn that the flow of electrons creates conductivity.

Social Studies: Students will learn how the development of an new material can change technology and affect society.

Critical Thinking Skills Reinforced

Students will make deductions about superconductors by becoming involved in technology through experiments. They will observe the experiment and record results in chart and written forms. Through this process they will be able to make generalizations about conductivity.

Teaching Tips

1. The written student "Procedures" are a very simple demonstration of superconductors. If you would like to get into more detail, and you have the equipment, there are a number of resources to help you make your own superconductor.
2. Your students will need additional information to help them understand magnetism and the flow of electrons as it relates to electricity if you make your own superconductor. Make a transparency of the Electron Flow sheet to explain those principles.
3. The instructions to make your own superconductor from scratch are in the September 1988 issue of *The Technology Teacher*, in an article titled, "Making Superconductors in the Technology Laboratory." It is an excellent article that gives detailed, step-by-step instructions.
4. If you would like to purchase a ready-made superconductor, here are two sources.

   Edmund Scientific Co.
   101 E. Gloucester Pike
   Barrington, NJ, 08007-1380
   (609)-573-6250

   Broadhead Garrett
   223 South Illinois Ave.
   P.O. Box 8102
   Mansfield, OH 44901-8102
   (419)-589-1800

   The kits and prices are different, depending on the supplier.

5. The experiment requires a samarium cobalt magnet. These can be found in lightweight headphones.

Instructional Strategy

- Conduct this activity to give your students a concrete experience to establish an understanding of electrical conductivity.
- Lead them to reflect on the flow of atoms and the resistance of the conductor.
- Through the results of the experiment, help them formulate generalizations that can be applied to superconductors.

Equipment/Supplies

1. Four large funnels
2. Sand
3. Current articles on superconductors
4. Four glass containers
5. Marbles
6. Measuring cup
7. Paper towels

Evaluation Key

Evaluate students on their cooperation and participation throughout this activity.

Support Materials

1. Ford, Robert. "The Search for a Super Superconductor," *Ties*, May/June 1989, 31-34.
2. Gradwell, J., et al. *Technology Shaping Our World*. South Holland, Ill: Goodheart-Willcox, 1991.
3. Komacek, S. *Production Technology*. Albany, N.Y.: Delmar, 1992.
4. "Superconductors and Other Electromagnetic Materials," *The Technology Teacher*, February 1989, 15-22.

Conductivity Experiment Record

Funnel	**#1 Sand** **(Black)**	**#2 Marbles** **(Red)**	**#3 Paper** **(Green)**	**#4 Empty** **(Blue)**

Seconds

20												
19												
18												
17												
16												
15												
14												
13												
12												
11												
10												
9												
8												
7												
6												
5												
4												
3												
2												
1												
0												
	5	6	7	8	9	10	11	12	13	14	15	16

Ounces

Answer the following questions.

How much time did it take the water to flow through each funnel?

#1________________ #2________________ #3________________ #4________________

How much water flowed through each funnel?

#1________________ #2________________ #3________________ #4________________

Which "conductor" offered the most resistance?

____

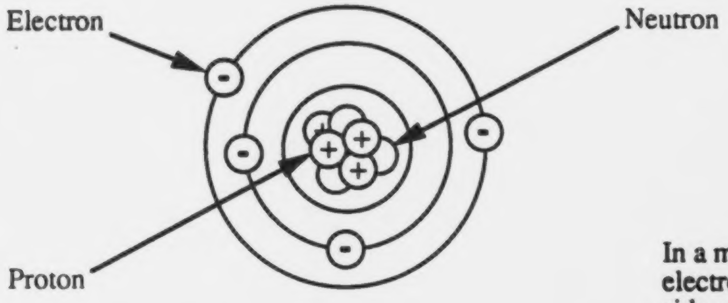
Which conductor offered the least resistance?

____

Which conductor could be compared to the superconductor? Why?

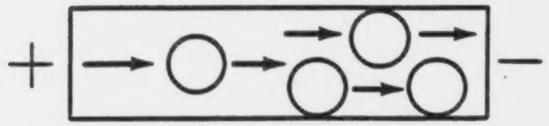
____

Electron Flow—Conductivity



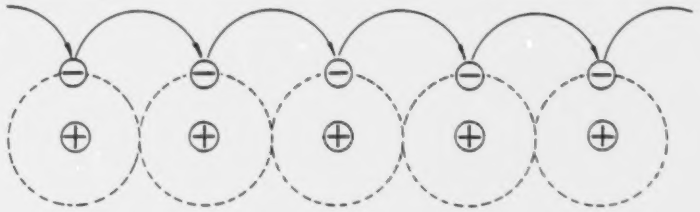
The balance of the atom determines its charge.

In a magnet, the side with more electrons is "negative," and the side with fewer electrons is "positive."

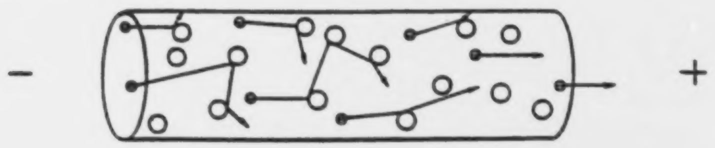


Electric current is caused when a force is applied to one end of a wire, pushing the free electron from one atom to the next.

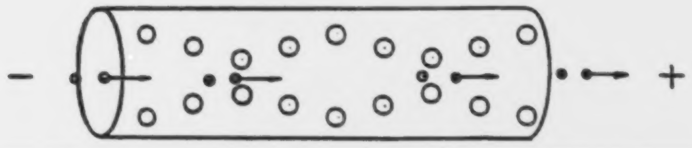
The Flow of Electrons



Normal Conductor



Superconductor



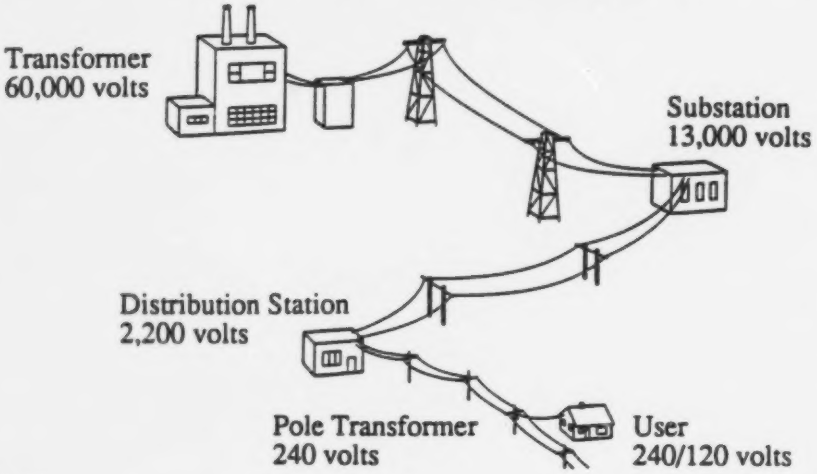
SUPERCONDUCTORS—WHAT'S EVERYONE SO EXCITED ABOUT?

Conduct simple experiments with water to help you understand the benefits of superconductors.

Challenge Statement

In most cases, electricity is transmitted over long distances from the power plant to our homes, schools, and businesses through wires. Because wires resist the flow of electricity, it must be transmitted at extremely high voltages to reach users. The voltage is reduced and divided at a substation, then stepped down again at a distribution station to be sent to pole transformers. The pole transformers reduce the voltage to between 480 volts (industry) and 240 volts (homes and businesses).

A generating station may start with 60,000 volts which ends up as 240 or 120 in our homes, schools, and offices. Although this system has worked for years, it is far from efficient.



Objectives

- To conduct experiments to help you understand simple principles of electricity
- To understand the advantages of superconductors to technology

Vocabulary/Concepts Reinforced

- Resistance
- Superconductivity

Supplies

- Four large funnels
- Sand
- Current articles on superconductors
- Four glass containers
- Marbles
- Measuring cup
- Paper towels

Introduction

Don't stand in water when working with anything electrical. That's a common safety rule, because water conducts electricity. When trying to understand electricity, we can compare the flow of water through a pipe to the flow of electricity through a wire.

After electricity is generated, it is distributed through insulated wire to users. Some electric energy is lost through resistance in the wire, and resistance causes heat. You can understand the heat loss by touching a motor that has been running for a while. This indicates a loss of energy.

The ideal conductor of electricity would not resist the flow or lose energy to heat. That, in a nutshell, describes superconductors. Superconductivity in a material allows electricity to flow indefinitely without the loss of energy. That may not sound like much, but the implications to technology are great.

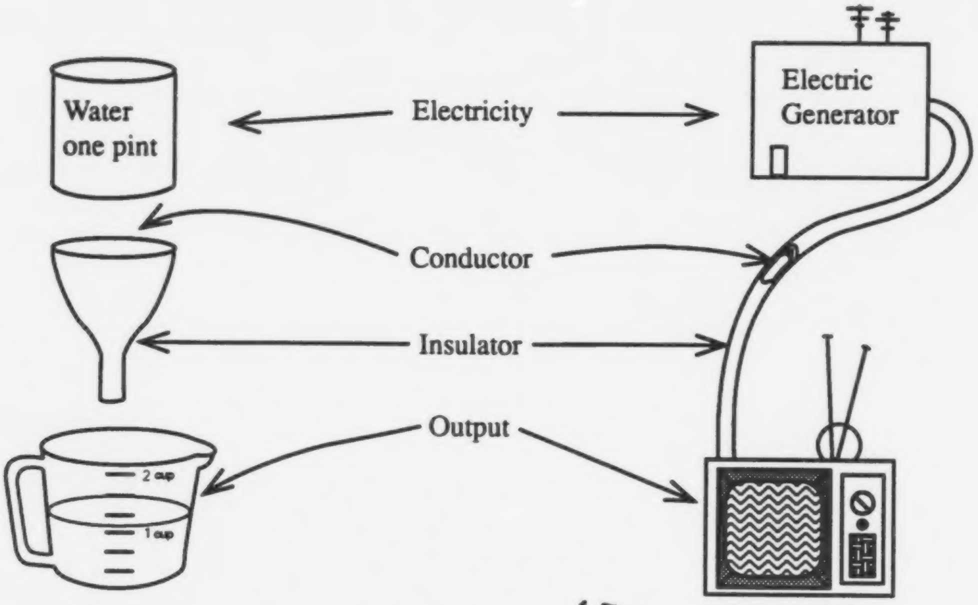
Superconducting generators produce about twice the electricity of conventional generators. They transmit data 100 times faster than state-of-the-art fiber optics. It would appear that electricity would flow forever without decreasing in superconductive materials.

The discovery of superconductive materials came in 1987, with the development of the combination of ceramic oxides. Bell Lab researchers found that a combination of copper, oxygen, barium, yttrium, and lanthanum was superconductive at -27°C. The superconductor must be cooled with liquid nitrogen to take advantage of the conductivity.

Now that scientists and technologists know that such a material is possible, they are racing to find a superconductive material that will retain its conductivity at room temperature. Why a race? Profits. The company or individual who discovers the new material will not only be famous, but also wealthy. In addition to that, technology and society will benefit from the development.

Procedure

1. To understand resistance, conduct the following experiment.
   You will use water to demonstrate the flow of electricity. The funnel will be the insulation of the electrical wire, and the material in the funnel will be the metal in the wire that carries the electricity and offers resistance.



Observe your instructor as he or she demonstrates the experiments. Record the results.
Read all the steps before you begin.
  a. Assemble four large funnels over four large glass containers.
    (1) In one funnel, put one cup of sand. You will need to put a fine mesh over the opening of the funnel to keep the sand from coming through.
    (2) In the second funnel, put one cup of marbles.
    (3) In the third funnel, put four or six wadded up paper towels.
    (4) Leave the fourth funnel empty.
  b. Pour one pint of water into each funnel.
  c. Time how long it takes to collect the water in each container.
  d. Measure the water that drained into each container.
2. Plot the information on the graph.
3. Answer the following questions as a class.
  a. How much time did it take the water to flow through each funnel?
  b. How much water flowed through each funnel?
  c. Which "conductor" offered the most resistance?
  d. Which conductor offered the least resistance?
  e. Which conductor could be compared with the superconductor? Why?
4. Discuss current events articles about developments in superconductivity.

Evaluation

You will be evaluated on your cooperation and participation throughout this activity.

INFRASTRUCTURES—PROBLEMS AND SOLUTIONS

Essential Elements:	75.50(b): 2A, 2C, 2D, 3A, 3B, 6A, 6B, 6D, 7A, 7B, 8B 75.50(f): 10, 12, 15
TAAS Objectives:	Language Arts: RC 1-6; WC 1-4

Activity Overview
Your students will learn the workings of an infrastructure and determine solutions for existing structures or design new, low-maintenance structures.

Challenge Statement
We have all seen potholes or water bubbling through the pavement, or smelled a light scent of natural gas when walking or driving through a neighborhood. These are problems with the infrastructure, "the structure beneath" our feet.

Many of our cities and neighborhoods have been developed for decades, and the erosion of pipes and roads is causing major problems and expense in our communities. Authorities are finding that money and ideas for solutions are short. *U.S. News and World* reported that investments in infrastructures fell from 2.4 percent of the gross national product in 1967 to 0.3 percent by 1982. Obviously, although the need is greater, the available funds are less. Japan spends 5.1 percent maintaining and expanding their infrastructure. To maintain our standard of living, we will need to find solutions for this dilemma.

Through this activity, your students will realize and appreciate technology underfoot. It's easy to take for granted things we cannot see. This will give them an appreciation of another subsystem of technology.

Systems Model
Resources
Students as learners, engineers, and inventors
Instructor as resource person, moderator, and evaluator
Blueprints and handout, Problems and Solutions of Infrastructures

Processes
Reading and studying new concepts
Surveying blueprints
Designing infrastructure solutions
Evaluating solutions

Applications
Problem solving to real-life problem
Technology knowledge to design solution

Impact
Career choices
Social lifestyle
Technology awareness

Interfacing with Other Disciplines

Language Arts: Students will learn new terms and concept. They will record information in writing.
Mathematics: Students will read and interpret blueprints.
Science: Students will understand concerns with transporting natural resources for use in our communities.
Social Studies: Students will understand how infrastructures affect lifestyle.

Critical Thinking Skills Reinforced

Students will identify facts and concepts about infrastructures. They will develop an understanding of the magnitude of infrastructures and the immediate and potential problems. Using their level of technical knowledge and skills, they will develop solutions. Each student will have the opportunity to report his/her solutions and analyze solutions of classmates.

Teaching Tips

1. Check with your school librarian, and gather articles about problems and solutions with infrastructures. Two articles that come to mind are the San Francisco earthquakes and the Brenham, Texas, explosion in the spring of 1992.
2. Have a sufficient number of blueprints or copies of blueprints for students to highlight various substructures coming into the building.
3. Emphasize the fact that this is a high needs area, therefore, a high opportunity area.

Instructional Strategy

- Open the class by presenting infrastructures as a subsystem of technology and construction. Help students identify infrastructures by reviewing blueprints.
- Lead them to identify substructural problems in your community through discussion and brainstorming.
- Expand the application with articles about infrastructure problems in other communities.
- Define desired solutions and goals, then monitor students as they explore solutions.
- Evaluate solutions in light of the standards and goals set.

Equipment/Supplies

1. Blueprints
2. Current events articles

Evaluation Key

Each Problems and Solutions of Infrastructures handout will vary according to the creativity of your students.

Support Materials

1. Construction textbooks
2. Hanson, Wayne. "Smartening Up Our Infrastructure," *Government Technology, Managing State and Local Government in the Information Age*, Vol. 5, April 1992, 1, 47-50.

Modifications for Handicapped, Disadvantaged, and LEP Students

No modifications are necessary for this activity, just encouragement.

Problems and Solutions of Infrastructures

Infrastructure	*Problem*	*Possible Solution*
Roads	Deteriorating surfaces Traffic accidents and jams	Private toll roads "INductive RADio loop" (INRAD) Traffic Operations Control Center (TOC)
Pipes	Broken or leaking underground	Video/computer system
Sewer Pipes	Broken and leaking pipes pollute water supply.	Locate and replace pipes.
Irrigation Water for Agriculture	Overwatering produces saline in soil and runoff. High utility costs for pumping. Chance of collapsing underground aquifer.	Underground moisture-sensing equipment measures exact watering needs.
Utilities	Eroded wires and cables Interrupted service	______________________

Choose one area from the different infrastructures, and describe a solution that you feel would eliminate the problem. You can determine how to fix existing structures or describe a new structure that would be easy to maintain. Write on the back if you need the space.

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INFRASTRUCTURES—PROBLEMS AND SOLUTIONS

Learn the workings of an infrastructure, and determine solutions for existing structures or design new, low maintenance structures.

Challenge Statement
We have all seen potholes or water bubbling through the pavement, or smelled a light scent of natural gas when walking or driving through a neighborhood. These are problems with the infrastructure, "the structure beneath" our feet.

Many of our cities and neighborhoods have been developed for decades, and the erosion of pipes and roads is causing major problems and expense in our communities. Authorities are finding that money and ideas for solutions are short. *U.S. News and World* reported that investments in infrastructures fell from 2.4 percent of the gross national product in 1967 to 0.3 percent by 1982. Obviously, although the need is greater, the available funds are less. Japan spends 5.1 percent maintaining and expanding their infrastructure. To maintain our standard of living, we will need to find solutions for this dilemma.

Objectives
- *To become aware of the "industry" beneath our feet*
- *To become aware of technology necessary to run society*
- *To realize a potential career field*
- *To develop solutions to a technological problem*

Vocabulary/Concepts Reinforced
- Infrastructure
- Irrigation
- INRAD
- TOC

Equipment/Supplies
- Problems and Solutions of Infrastructures handout
- Blueprints
- Current events articles

Introduction
Now that we have defined infrastructures and problems surrounding them, let's look at some of the solutions. Engineers and technologists are designing technology to fix existing structures, but, more importantly, they are formulating ways to build new structures, using current materials and techniques that will eliminate many of the problems in the future.

One of our biggest problems are our roadways, not only because of maintenance, but also because of traffic congestion. Currently, the solution for our roads involves making repairs as money will allow. Many larger cities are building tollways that are funded by investors or the state to cut down on the flow of traffic and cover the costs of maintenance and expansion. Another long-term solution would be to develop road materials that will be more durable under traffic, requiring fewer repairs.

Several states are studying and testing the use of new technology to survey and regulate traffic. California is testing a system along the Pomona Freeway called "INductive RADio loop" (INRAD) which is a system of two-way communication with road vehicles. These radio loops work as short-range radio antennas that both send and receive messages. These units would eventually connect to a Traffic Operations Control Center (TOC) that would be similar to Air Traffic Control Centers. Motorists would be warned in advance about accidents or clogged traffic ahead and be given alternate routes. This would eliminate pile-ups, saving time and money. On a daily basis, these TOCs would regulate the flow of traffic getting on and off expressway ramps, allowing for more constant speeds, avoiding traffic jams.

Underground pipes are becoming a serious problem in major cities. Pipes carry water and gas to buildings and remove sewage from buildings. Leaky and broken pipes waste water and pollute our water supply. Because of all the asphalt and concrete in cities, leaks and breaks often go undetected, and when discovered are difficult to locate and costly to fix.

Pipes also transport water for irrigation. Irrigation is a concern because of the volume of water necessary to grow our crops. In California, 80 percent of the water supply goes to water crops. Because it is difficult to determine exactly how much water plants need, farmer often overwater. Continuous overwatering causes runoff of pollutants into our water supply and produces saline, which is harmful to plants over time. Besides wasting water, it take large amounts of electricity to pump water long distances.

Pipes transport gases for heating, cooking, and industrial uses. Faulty gas pipes are very dangerous because of explosions and asphyxiation. In areas like San Francisco where the ground shifts, pipes are often ruptured, causing fires and explosions. Not much has been done technologically to remedy the problem to date.

Experiments are being conducted with small video cameras that travel with the flow of fluid or gas in pipes. These cameras are timed as they go through a section of pipe. The video is replayed, hopefully recording the leak or break, and the location is determined by the time on the film.

Presently, underground utilities have not presented the magnitude of problems as other underground structures. Traditionally, electricity and telephone service is transported over ground on poles. It is only recently that utilities have been buried. Twenty years from now we may see similar challenges with utilities. But with the advent of satellites, fiber optics, and superconductors, the transport of utilities is changing rapidly. As new technology develops, transmissions systems will change.

Any business or individual who finds solutions or alternative structures will profit from the service they provide in remedying these growing problems.

Procedure

1. Read and study the information above. Discuss areas in your community that show signs of infrastructure stress.
2. Study blueprints, and identify all the systems that are part of an infrastructure. Use a colored marker to code and identify each subsystem.

Study and complete the Problems and Solutions of Infrastructures handout.
3. Share your ideas with the class. As each student reports, put a brief description of ideas on the board.
4. Turn in your work.

Evaluation
You will be graded on your Problems and Solutions of Infrastructures handout.

SELF-SUSTAINING HABITAT IN AN ALIEN ENVIRONMENT

Essential Elements: 75.50(b): 1A, 2C, 2D, 4A, 4B, 5A, 5B, 6A-E (computer application), 7B, 8A, 8B
75.50(f): 1, 2, 5, 6 (computer application), 7 (computer application), 9, 10, 13, 15, 19
75.50(g): 1I, 2B, 2C, 2G, 2I

TAAS Objectives: Language Arts: RC 1, 2, 5, 6; WC 1, 2, 4
Mathematics: C 1, 4, 5; O 1-4; PS 1, 2, 4

Activity Overview

Working in groups, the students will research, design, and build a model of a community in an alien environment (space, underground, underwater) that is able to support itself for up to five years.

Challenge Statement

At the current rate of devastation to the world's environment through overcrowding and pollution, the land available to live on and produce the things we need to live will be greatly reduced in the near future. You will no longer be able to live on the surface of the earth.

Your students' goal is to produce a system that could support human life in an alien environment for five years. The alien environment may be below the ground, in the sea, or somewhere in outer space.

From the research obtained, the students will design and build a model that will incorporate all of the aspects of society. They will plan everything they need to live or desire to have in this environment, from the form of government, law enforcement, economics, medical care, and the production of food, oxygen, and clothing. The size of this project should be limited only by your students' imagination and ability.

Systems Model

Resources
Students as designers, inventors, engineers, architects, and builders
Teacher as resource person and facilitator
Structural and recycled materials for building materials for models
Model building tools
Books, magazines, and journals for research and reference

Processes
Research alternative living environments
Discuss and brainstorm possible living environment solutions
Plan and design alien living environments
Create models of alien living environments
Present models of alien living environments

Applications
Develop an awareness of environmental issues

Problem-solving environmental solutions
Understand the difference between needs and wants
Prioritize needs

Impact
Gain insight into the overall needs of society
Understand the general concepts necessary for social order
Objectively evaluate social values
Predict long-term effects of continued environmental abuses

Interfacing with Other Disciplines

Mathematics:	Students will calculate the amount of space needed to sustain life within an enclosed environment. Amounts of food, clothing, housing, jobs, etc., will also be determined.
Science:	Students will explore concepts such as pollination of plants, production of oxygen, CO_2 requirements of vegetation, water purification, gravity, agricultural methods, orbits, beneficial animals, and basic medical needs.
Language Arts:	Students will complete a research paper on their self-sustaining habitat. An oral presentation will be given to the class at the conclusion of the project.
Social Studies:	Each group will develop the society of the habitat. The possible applications to social studies are unlimited.

Critical Thinking Skills Reinforced

Students will analyze, synthesize, design, and evaluate their habitats based on the information gathered through independent and group research. They will be required to research, organize, prioritize, and apply various solutions to the problem before drawing conclusions about workable alternative living environments. Through group reports, the students will gather insight into an even broader range of alternative solutions created by other groups.

Teaching Tips

1. Introduce the topic by reading the memo from Hugh J. Nose.
2. To begin this activity, it is helpful to discuss in class all of the aspects in society that are necessary for life. List them on the board to give students a basis for research. When you divide the class into teams, have each team divide up the responsibility for researching the different aspects of society. Remember to schedule use of the library in advance to ensure access to materials.
3. Don't let the students get too bogged down in details. Remember this course is introductory. If the students are overwhelmed by all the information, ask "leading" questions such as "What are you going to do with the trash you have?", "What are you going to do with the dead people?", "How are you going to maintain the level of oxygen available?" Have the groups write down their responses and continue with questions on their own.
4. Set up static displays well before the activity that demonstrate some of the principles involved in a self-sustaining habitat. Examples are hydroponic greenhouse, terrarium, aquarium, solar panels, wind energy (depending, of course, on where the habitat is based), etc.
5. Display models so that the school can see the work of the students.
6. Invite teachers from the school to sit in as "members of the board" to choose the best models and presentations from each class. Schedule teachers from science, language arts or speech, social studies or government, and mathematics if possible. Use teachers on their planning periods. Most teachers are delighted to see their students' work in other classes, especially when the work interacts with their classes. Students will also perform better during presentations if other teachers are watching.
7. If the makeup of the class does not lend itself to a proper teamwork environment, this activity may become a class project. Each class can work collectively on the same solution. The

teacher can lead the class through the problem solving/design process using classroom discussion and participation. Assign individual tasks to ensure success.

8. Videotape presentations for critique and future reference. The students enjoy watching themselves when it's over.

Instructional Strategy

- Introduce this activity by applying it to some real world problem. For example, modify the activity so that students must reorganize (in space) a foreign country that is in trouble, such as the Soviet Union breakup, or rebuilding Kuwait.
- Through class discussion, identify the aspects of society that are necessary for survival. When the class breaks into groups the students can research each aspect.
- Advanced groups can schedule work on the habitat on their own. Some groups may need deadlines for each aspect (research, design, and model) of the habitat to ensure successful participation.

Equipment/Supplies

1. 1/8" x 24" x 24" Masonite boards (or suitable material) for base of models
2. Recycled materials for construction of models.
3. Hot glue guns and glue
4. Miscellaneous separating tools, e.g., X-acto knives, box saws, scissors
5. Video camera
6. Presentation media

Evaluation Key

Each group will turn in a written research paper, an oral and visual presentation, sketches, and a scaled model of the habitat. Evaluation should first be based on participation during the activity. The report and presentation should be judged on imagination and originality instead of whether or not the concept will work. The report should contain at least a set amount of information such as production (oxygen, agriculture, water, living space, clothing) transportation, communication, an explanation of the society (government, education, entertainment, economics, law enforcement), and the impact technology has on aspects of the habitat. Emphasis should not be placed on the model, but it should be checked for proper scale and correlation with plans and sketches and quality of workmanship.

Modifications for Handicapped, Disadvantaged, and LEP Students

LEP students will need additional help in understanding the assignment and doing research. Handicapped students may need help in model building. The group may be enough assistance, if they work well together.

The Technology Company

MEMORANDUM TO ALL ENGINEERS

FROM: Hugh J. Nose

SUBJECT: Space-based self-sustaining habitat

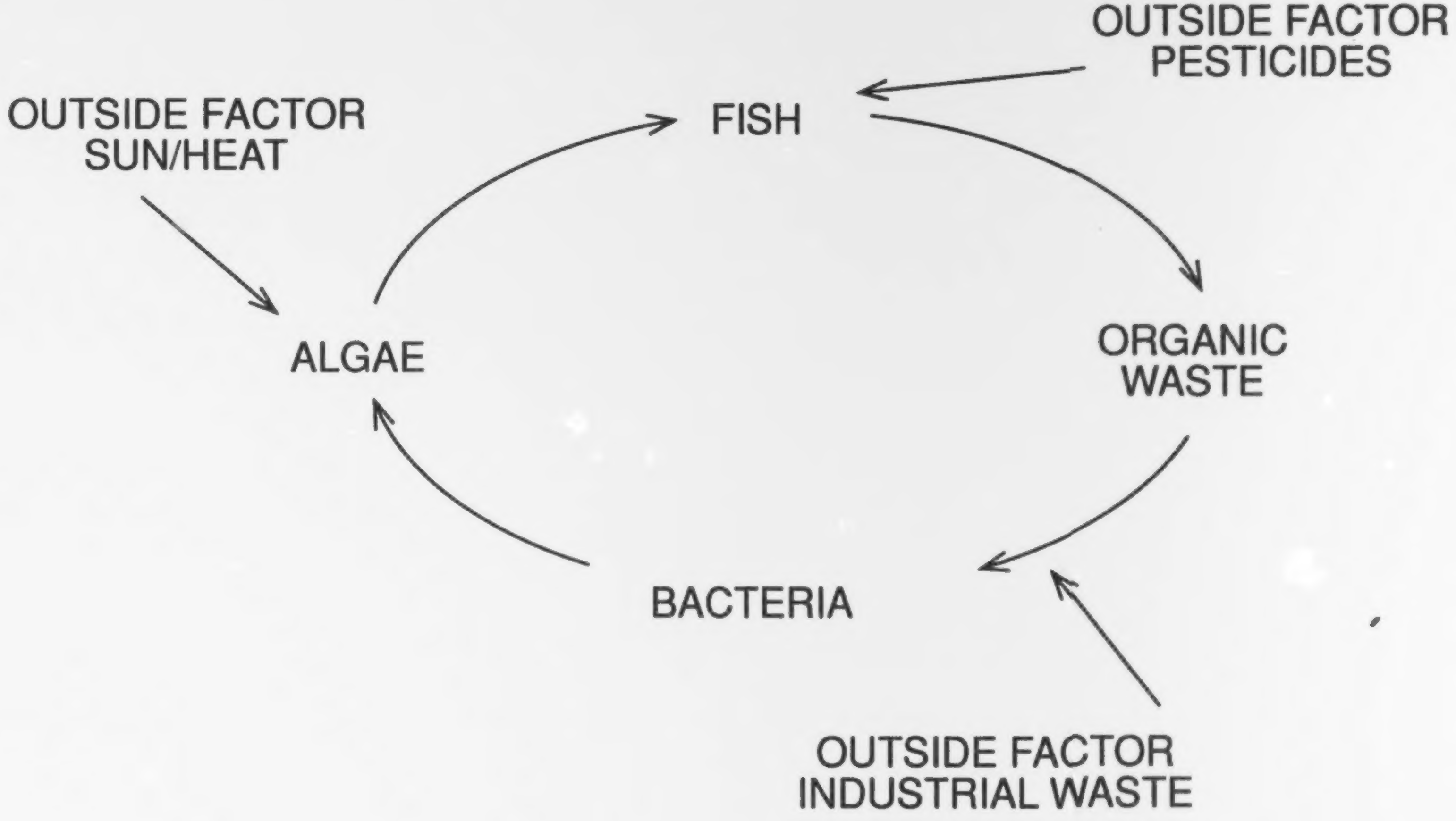
At the current rate of devastation to the world's environment through overcrowding and pollution, the land available to live on and produce the things we need to live will be greatly reduced in the near future. The United States wants to lead the world by designing and building the first community in space that will support itself indefinitely.

Working in research/design teams of four to five people, you will help solve this problem by designing a community in space that is able to support itself. Your design team will design every aspect of the community including (but not limited to) the production of goods such as oxygen, water, food, clothing, and houses; transportation within the habitat; communication; and parts of the society such as government, entertainment, education, economics, and law enforcement. Most importantly, you should try to predict what the impact of technology will be on this new environment. Are the effects positive or negative?

In this activity, each design team will produce a written report that covers all aspects of the habitat. The report will be presented to the board of directors, who will choose the design they want to invest in. Each team will use visual media to enhance the presentation of the design. A model will also be constructed to scale to represent the major features of the habitat.

Designing Tomorrow Today

ECOLOGICAL CYCLE



OUTSIDE FACTOR
PESTICIDES

OUTSIDE FACTOR
SUN/HEAT

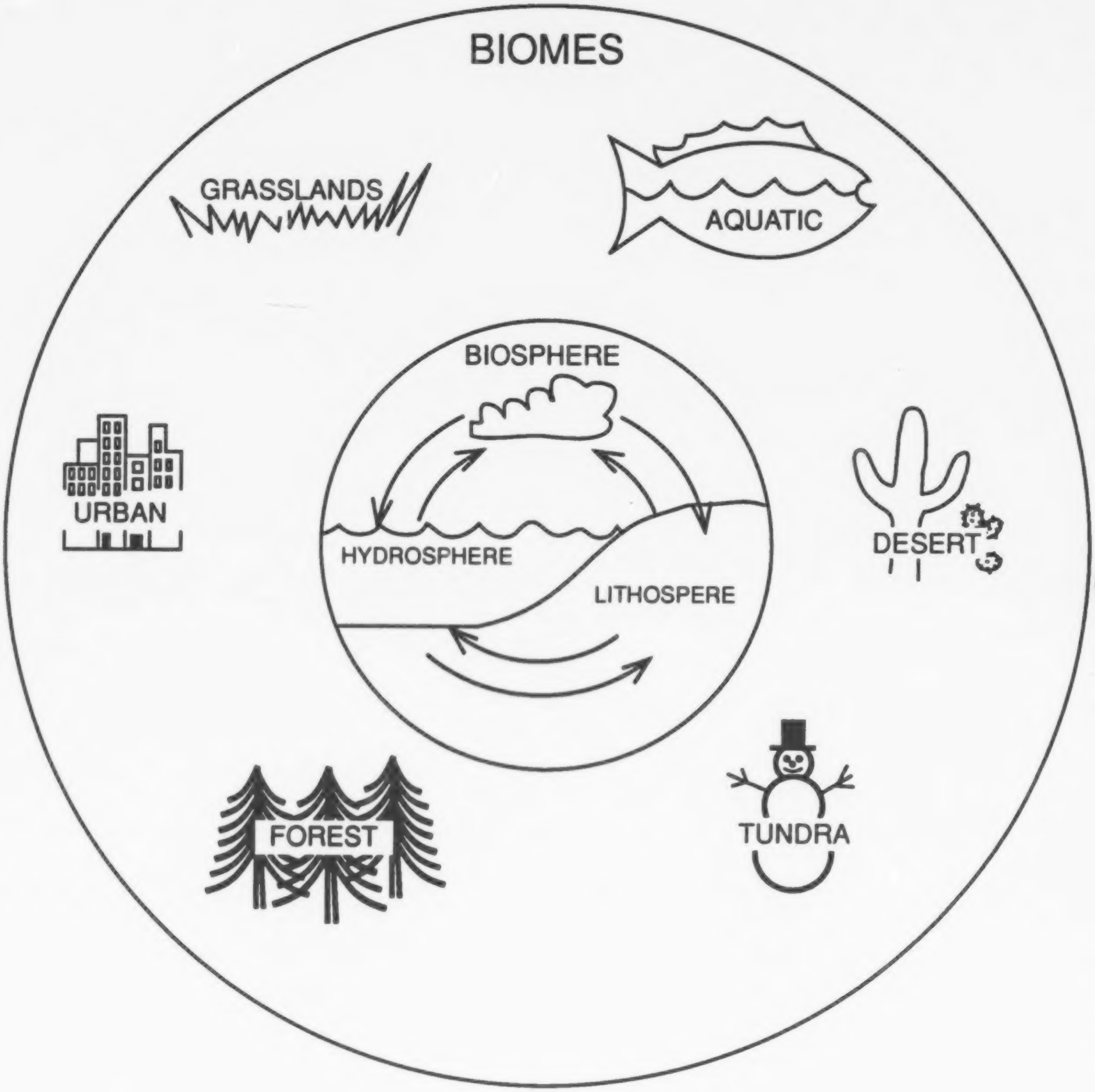
FISH

ALGAE

ORGANIC
WASTE

BACTERIA

OUTSIDE FACTOR
INDUSTRIAL WASTE


BIOMES
GRASSLANDS
AQUATIC
BIOSPHERE
URBAN
HYDROSPHERE
LITHOSPERE
DESERT
FOREST
TUNDRA

SELF-SUSTAINING HABITAT IN AN ALIEN ENVIRONMENT

Research, design, and build a model of a community in an alien environment (space, underground, underwater) that is able to support itself for up to five years.

Challenge Statement

At the current rate of devastation to the world's environment through overcrowding and pollution, the land available to live on and produce the things we need to live will be greatly reduced in the near future. You will no longer be able to live on the surface of the earth.

Your goal is to produce a system that could support human life in an alien environment for five years. The alien environment may be below the ground, in the sea, or somewhere in outer space.

From the research obtained, you will design and build a model that will incorporate all of the aspects of society. You will plan everything you need to live or desire to have in this environment, from the form of government, law enforcement, economics, medical care, and the production of food, oxygen and clothing. The size of this project should be limited only by your imagination and ability.

Objectives

- To understand the aspects of the community in which we live which are necessary to support an orderly living environment
- To understand the impact technology has on all aspects of life
- To apply technology to an environment in an alternative living environment

Vocabulary/Concepts Reinforced

- *Habitat*—the place in which we live.
- *Society*—a community, nation, or group of people who have common traditions, institutions, and collective activities and interests.
- *Environment*—the surroundings that influence the life of a group of people, person, or organism.
- *Biosphere*—living beings together in their environment.
- *Biome*—a major ecological community; for example, grasslands, aquatic, etc.
- *Recycle*—to make something useful out of materials that have been used before.
- *Self-sustaining*—the ability to support oneself forever without any outside help.
- *Impact*—the effect, positive or negative.
- *Community*—a group of people unified through a common environment and society.
- *Model*—a three-dimensional representation of an object, many times constructed to scale.
- *Scale*—a proportion between two dimensions—actual dimensions and represented dimensions (example: 1/4" = 1').
- *Hydroponics*—growing plants without soil.
- CO_2—carbon dioxide, which is absorbed from the air by plants in photosynthesis.
- *Ecology*—an order in which events naturally occur in the environment. For example, within a freshwater ecological cycle, when the temperature of the water rises so does the growth of algae which deplete the supply of organic nutrients within the water. However, as algae grow, it provides for easier feeding of fish which in turn increases its waste production. The fish, therefore, decrease the algae population by feeding and increase the level of nutrients when the waste decays. As a result of this cycle, the balance of nature remains stable. When one step in the cycle is taken out, an improper balance of natural order occurs. Nature was not designed to

handle large amounts of industrial wastes, chemicals, nonbiodegradable materials, and other residue of human technology. The result of these things is often an unbalanced ecology.

- *Agriculture*—producing crops and livestock and preparing them for use by people.
- *Vegetation*—plant life.
- *Gravity*—the gravitational attraction (pull) of the mass of the earth, moon, or other heavenly bodies at or near its surface.
- *Orbit*—a path of one thing (satellite, planet, moon) around another object (earth, planet, sun).
- *Ecosystem*—a system within the environment in which everything is connected to everything else and is stabilized by self-compensating elements.

Equipment/Supplies

- 1/8" × 24" × 24" Masonite board (or suitable material) for base of model
- Recycled materials for construction of models
- Hot glue guns and glue
- Miscellaneous separating tools, e.g., X-acto knives, box saws, scissors
- Presentation media (video camera, poster board, cassette tape recorder, cameras, flip charts, overhead projectors, etc.)

Introduction

In the near future the world will run out of land to live on and produce the things we need to live. Working in research/design teams of four to five people, you will help solve this problem by designing a community in an alternative living environment that is able to support itself. Your design team will design every aspect of the community including (but not limited to) the production of goods such as oxygen, water, food, clothing, and houses; transportation within the habitat; communication; and parts of the society such as government, entertainment, education, economics, and law enforcement. Most importantly, you should try to predict what the impact of technology will be on this new environment. Are the effects positive or negative?

In this activity, each design team will produce a written report that covers all aspects of your habitat. The report will be presented to a board of directors who will choose the design they want to invest in. Each team will use visual media to enhance the presentation of the design. A model will also be constructed to scale using wood strips for structural parts of the habitat structure and recycled materials for the rest. Build the model on a 24" × 24" base, and adjust the scale to fit.

Procedure

1. Use the problem-solving process (or design process) to find the solution to this problem. Remember that your only limitation is that it must be placed outside of the earth's normal atmosphere with no outside help.
2. Brainstorm the aspects of society that we need for survival.
3. Divide the members of your team into research teams of one or two persons who will be responsible for researching and designing specific aspects of your habitat. It will be helpful to elect a group leader to supervise the rest of the team. Schedule available time and resources so that you will complete the research and design of your habitat with enough time to complete the model and presentation.
4. In your research paper, include this information as an introduction:
   a. Definition of a self-sustaining habitat
   b. A drawing of a simple ecological cycle

    c. A description of what happens when one or more steps are taken out of the ecological cycle

5. Upon completion of the written research, begin keyboarding the report into a word processor. If you have the right software, use the computer for your model drawings. Other members of the group can begin layout and production of the model. **Read the evaluation section for the requirements for your written report and the model.**
6. Produce a visual aid using available media that will assist in "selling" your idea to the board.
7. Practice your presentation using all members of the team.
8. Give the oral and visual presentation. Turn in your assignments.

Evaluation

1. Your final grade for this activity will be based on:

Report/Research	40%
Model	30%
Presentation	20%
Visual Aids	10%

**Note:* Percentages should be adjusted to meet specific classroom requirements.

2. Project self-evaluation:

Did you use the design process?		YES	NO
Does your report cover a minimum of the following aspects of society in your habitat?			
Production of:	Oxygen	YES	NO
	Food	YES	NO
	Water	YES	NO
	Living space	YES	NO
	Clothing	YES	NO
	Luxury items	YES	NO
	Transportation	YES	NO
	Communication	YES	NO
	Government	YES	NO
	Education	YES	NO
	Economics	YES	NO
	Law enforcement	YES	NO
	Entertainment	YES	NO
Does your model meet the following requirements?			
Is it made to the proper scale?		YES	NO
Does it include necessary facilities?		YES	NO
Does it look the same as your sketches?		YES	NO
Did you take your time and make it look good?		YES	NO
Does your presentation adequately describe your habitat?		YES	NO
Do your visual aids enhance the subjects discussed in your presentation?		YES	NO

INSTRUCTOR'S RESOURCE SHEET 19
(ONE DAY)

SURPRISE INVENTIONS

Essential Elements: 75.50(b): 1A, 2C, 2D, 3A, 4A, 4B, 6B, 6D, 7A
75.50(f): 1, 2
Others—depending on topic chosen
TAAS Objectives: Language Arts: RC 1-6

Activity Overview

This activity involves the invention process. It approaches it, however, from a different perspective—mistakes that became important inventions.

Challenge Statement

The invention process is an important issue facing the industrial technology curriculum. The process is closely related to developing creative thinking and problem-solving skills. Students must be encouraged not to be discouraged by their attempts at invention. This activity will illustrate how some inventions are actually the result of mistakes.

Systems Model

Resources
The book, *Mistakes That Worked*
Students as researchers and presenters
Teacher as resource person and monitor

Processes
Researching inventions
Organizing materials
Presenting information
Preparing graphics display

Applications
Evaluating and reevaluating results of experiments
Creativity to inventions

Impact
New products for society
Creative career choices

Interfacing with Other Disciplines

Language Arts: Students will read about inventions and make an oral report.
Mathematics: Students will design graphic materials for presentation of inventions.
Science: Science skill may be used depending on the invention.
Social Studies: Students will see how inventions affect society.

Critical Thinking Skills Reinforced

Students will use application in demonstrating their knowledge of the topic, and analysis to analyze the information that they receive. Students will use synthesis in combining this information with other topics related to the invention process. Students will then evaluate and weigh this information as it relates to invention-related topics.

Teaching Tips

1. Obtain one or two copies of *Mistakes That Worked* for students to use in your class or lab area.
2. Create a bulletin board display related to the invention process.
3. Read the book before presenting the information to students, and bring in several examples of the inventions described in it.

Instructional Strategy

- Use group discussion to present the activity to students.
- Use small teams of two or three students to prepare their material.

Equipment/Supplies

1. Jones, Charlotte F. *Mistakes That Worked.* New York: Doubleday, 1991.
2. Several examples described in the book.

Evaluation Key

Students will be graded on the accuracy of their presentation as it relates to the book and the quality of their graphics display.

Modifications for Handicapped, Disadvantaged, and LEP Students

Because of the nature of this activity, little or no modification is needed. If special conditions do exist, however, instructors can make modifications as needed.

SURPRISE INVENTIONS

Prepare a presentation to the class related to the book Mistakes That Worked.

Challenge Statement

The invention process is an important element of industrial technology. Students are encouraged to become involved in the creative and critical thinking tasks that are needed for this type of problem solving.

Objectives

- To discuss and describe several inventions that were actually mistakes
- To discuss and describe the importance of creative thinking in relation to invention

Vocabulary/Concepts Reinforced

- Creative thinking
- Invention
- Problem solving

Equipment/Supplies

- Jones, Charlottte F. *Mistakes That Worked.* New York: Doubleday, 1991.

Introduction

The invention process is a very complex issue. Imagine for a moment all of the things around you that are the result of invention. Just about everything is tied either directly or indirectly to an invention—from paper clips to computers to the electric light bulb in the ceiling. We may think of inventing as being a complex set of processes done only by scientists and engineers in sophisticated research facilities. In fact, however, many of the inventions are the result of accidents or mistakes. That they became useful at all is more a result of someone recognizing the potential of a device or process to meet a particular need.

Procedure

1. Your instructor will divide the class into small groups of two or three students.
2. Each group is to select one invention described in the book, *Mistakes That Worked* and prepare a presentation for the entire class. The presentation should include some form of graphic to help illustrate the topic.
3. The instructor may want the class to prepare a bulletin board display in an area where the entire school can view it.

Evaluation

You will be graded on the accuracy of your presentation as it relates to the book and on the quality of your graphics display.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 20
(2 WEEKS)

THE WAY THINGS WORK

Essential Elements: 75.50(b): 1A, 1C, 6D, 6E, 7A, 8A, 8B
75.50(f): 1, 2, 4
TAAS Objectives: Language Arts: RC 1-6; WC 1-7

Activity Overview

This activity is intended to introduce students to the book written and illustrated by David Macaulay, *The Way Things Work*. Students will select a topic from the book, prepare a short technical paper, and create a bulletin board display related to that topic.

Challenge Statement

Developing an interest in technical reference material is important for students enrolled in industrial technology programs. This book is a particularly good reference because of the way in which material is presented and illustrated.

Systems Model

Resources
Student as researcher, writer, and reporter
Teacher as monitor
The Way Things Work
Materials for display board

Processes
Reading Macaulay's book
Researching a chosen tool, machine or process.
Writing a technical paper
Designing and constructing a bulletin board or poster board

Applications
Reading and writing skills to technology research
Artistic skills to bulletin board

Impact
Technology appreciation and understanding

Interfacing with Other Disciplines

Science: Various technological concepts, physics, engineering, and other scientific principles
Language Arts: Written technical paper

Critical Thinking Skills Reinforced

Students will apply information in preparing a bulletin board display and a written technical paper on a particular topic. They will analyze the information, and then synthesize it to organize, design, and create a bulletin board display on the topic. Evaluation will be used to appraise the finished technical paper and bulletin board display.

Teaching Tips
1. Encourage craftsmanship in the preparation of the bulletin board display.
2. Have students complete a short technical paper that will support the topic.

Instructional Strategy
- Use a group discussion to present the activity to students.
- This should be used as an individual or small group activity.
- It is suggested that this activity be presented as an extra credit or supplemental activity for students to complete on their own time.

Equipment/Supplies
1. Computer with word processing program and printer
2. Construction paper
3. Markers, pencils, etc.
4. Macaulay, David. *The Way Things Work.* Boston: Houghton Mifflin, 1988.
5. Other technical reference material as available

Evaluation Key
Teacher evaluation of student performance should be based on participation in and completion of the activity. Keep in mind that the activity is intended to be used as either a small group or individual extra credit project.

Modifications for Handicapped, Disadvantaged, and LEP Students
This activity does not need significant modification to be used by special needs students. The activity can be used to help encourage special needs students to become involved in technology education. If needed, however, team special needs students with non-special needs students to complete the project.

THE WAY THINGS WORK

Review the book, The Way Things Work, *then select a topic, prepare a technical paper, and create a bulletin board display.*

Challenge Statement

Technical reference material is available for almost every type of technology. Much of it is written in technical terms for the technicians who need to utilize it or repair it. Students of technology should be able to write and illustrate basic technical information.

Objectives

- To perform basic steps in researching a technical subject
- To describe and discuss the way a technical process works
- To prepare a bulletin board display to help describe a technical process
- To write a short technical paper

Vocabulary/Concepts Reinforced

- *Research*—in a technical sense, research has to do with a thorough investigation and analysis of information.
- *Technical illustration*—a drawing that helps show the relationship of various parts of a device, or how a process works.
- *Technical reference*—generally refers to background information or detailed text and illustration material that describes a technical device or process.

Equipment/Supplies

- Computer with word processing program and printer
- Construction paper
- Markers, pencils, etc.
- Macaulay, David. *The Way Things Work*. Boston: Houghton Mifflin, 1988.
- Other examples of technical reference material as available

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Introduction

Technical reference material is available for every type of machine, tool, part, process, and procedure in existance today. In many cases, several volumes of reference books are needed to convey information on a single device. In some instances, the technical information is condensed for the consumer as in the case of an operator's manual that would be packaged with a new lawn mower. Technical writing is important, and industry relies heavily on people who can write technical data in a manner that leave little or no room for miscommunication of information.

Imagine, if you would, the amount of technical information that it takes to make up a repair manual for a car. The automobile manufacturer compiles several volumes of technical data for its own service personnel at dealerships, auto parts stores often sell a consumer's version of a service manual which condenses several volumes into one for the do-it-yourself mechanic, and the owner's manual included with the car condenses this same information even more into very simple terms for the automobile operator. The amount of information published in one form or another is massive, even for a relatively simple mechanical device such as a car or a truck.

How much technical information do you suppose it would take to support something as complex as a Boeing 757 passenger jet? The volumes of technical information range from service volumes on the sophisticated hydraulic systems to operating manuals for the pilots. Obviously, the more complex the technical system, the more complex and lengthy the technical information needed to support it. What about a nuclear power plant? The volume of information needed here would probably take up more space than your school has in its entire library.

The most important element related to a technical manual, however, is not its complexity, but its ability to clearly communicate information. Industry relies heavily on technical writers to perform this function. A technical manual does little good if the information it contains is not clearly understood by its intended audience.

Procedure

1. Your task for this activity is to select a tool, machine, or process and prepare a technical paper for it. In your paper you will need to make some reference to the following:
    - General background information
    - Safety considerations
    - Service and maintenance
    - Principle parts
    - Operating instructions

2. Upon completion of your technical paper, you will create a bulletin board display related to your topic.

Evaluation

Instructor evaluation of this activity will be based on participation in and completion of the project. It is recommended that this activity be used as either a small group or individual project.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 21
(2-3 DAYS)

EARLY TECHNICAL DEVICES

Essential Elements: 75.50(b): 2C, 5A, 6A, 6B, 6D, 7A, 7B, 8A
75.50(f): 2
TAAS Objectives: Language Arts: RC 1, 2, 4, 5; WC 1-4

Activity Overview

With your knowledge of tools and technology, you will help your students design a device that could have been used by prehistoric people to make their work faster and easier. Students will describe the job to be accomplished and the tool or tools they would invent to make the work easier. From this activity you will note the impact tools and technology have had on society.

Challenge Statement

Have your students think of themselves in early times with no tools and a job to do. They will need to invent a tool or combination of tools to help them accomplish their work. In this activity, they will describe the work they want to accomplish and design a tool that can make the job easier and increase productivity.

By using their imaginations and identifying with early humans, your students will begin to understand the progression and impact of technology on society.

Systems Model

Resources
Instructor as resource, inspiration, and monitor
Students as prehistoric people, problem solvers, and inventors
Sketching paper and pencil

Processes
Discussion of the past and future of technology
Imagining prehistoric times
Problem solving and inventing a tool or combination of tools
Evaluating the impact of technology on society

Applications
Imagination to problem solving
Sketching to design
Activity to conclusions about technology

Impact
Imagination
Creativity
Understanding of technology
Future of technology
Careers

Interfacing with Other Disciplines

Language Arts: Students will learn new words and describe the solutions to their problems in writing.

Science: Students will consider the different properties of materials in designing their tools.

Social Studies: Students will review the history and progression of tools and the impact of technology on different societies and cultures.

Critical Thinking Skills Reinforced

Through their imaginations and creativity, the students will create and solve a problem. From the activity they will draw conclusions about the impact of technology on society and project changes in the future.

Teaching Tips

1. Discuss the development and progression of tools with your students. This will help them get into the mood of the activity. Some of them may have trouble using their imaginations. Have a supply of books with pictures of different prehistoric times from your school library. Your librarian will locate them for you if she has sufficient notice. These books will trigger your students' imaginations.
2. Be sensitive to the fact that some students may not feel they can sketch. In that case, focus on the word description of the tool. Spend some time talking about the properties of materials and the types of materials that they may have available to use in their time frame.
3. If you have time, allow some of the students to share their problems, solutions, and sketches to begin the closing discussion.
4. In your closing discussion, compare technologically advanced countries to underdeveloped countries. Discuss the role of technology in society. Point out the three types of technological societies (agricultural-based, industrial-based, and information-based), and give examples of each. Point out how natural resources play a role in the technological economy of a country by determining their market.
5. You may want to display some of the papers.
6. The social studies teacher may want to do a compatible unit along with this activity.
7. An excellent follow-up to this activity is Module 22, "Are Simple Machines Really Simple?"

Instructional Strategy

- Open the activity with a discussion of the history of tools.
- Stimulate and encourage creativity by showing pictures of prehistoric people.
- Monitor the students as they design their own problems and solutions.
- Close the activity with an evaluation of the tools the students designed, and a discussion of the impact of technology on society.

Evaluation Key

Your students will be graded on the problems they presented as prehistoric people, and the solutions they created.

Name________________________________

The Tools of Early Man/Woman

Describe yourself as an early human.____

____

____

What is the job that you need to do?____

____

____

Sketch the tool or combination of tools that you think will accomplish the job.

Describe the tool or combination of tools.____

____

What materials did you use in the tool?____

How did you make it?____

____

Why do you think this is the best tool for the job?________________________________

____

____

Will it make your job easier?____

Will you be able to accomplish more work using this tool?________________________

EARLY TECHNICAL DEVICES

Design and describe an early tool that could have been used to make work faster and easier, and note the impact tools and technology have had on society.

Challenge Statement

Think of yourself in prehistoric times with no tools and a job to do. You will need to invent a tool or combination of tools to help you accomplish your work. In this activity, you will describe the work you want to accomplish and design a tool that can make your job easier and increase productivity.

Objectives

- To use your imagination to create a problem and find a solution
- To describe your solution through sketching
- To realize the impact of tools and technical devices on society

Vocabulary/Concepts Reinforced

- Tool
- Mallet
- Chisel
- Device
- Material properties
- Standardized parts
- Technological innovation
- Agricultural-based society
- Industrial-based society
- Information-based society

Equipment/Supplies

- Books on prehistoric people
- Sketching paper and pencil

Introduction

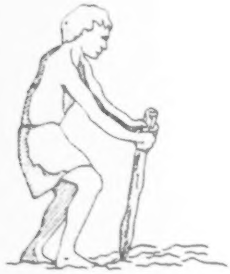
Prehistoric people needed both tools and weapons to gather food. As humans evolved, most of the work people did was in agriculture or construction. People designed simple copper chisels and wooden mallets and hoes to make their job easier and increase the amount of work they could do. Early people did not know manufacturing as it exists today. The development of tools, then machinery, is responsible for much of society as we know it.

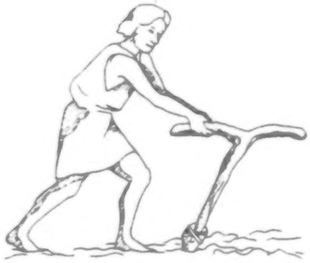
Procedure

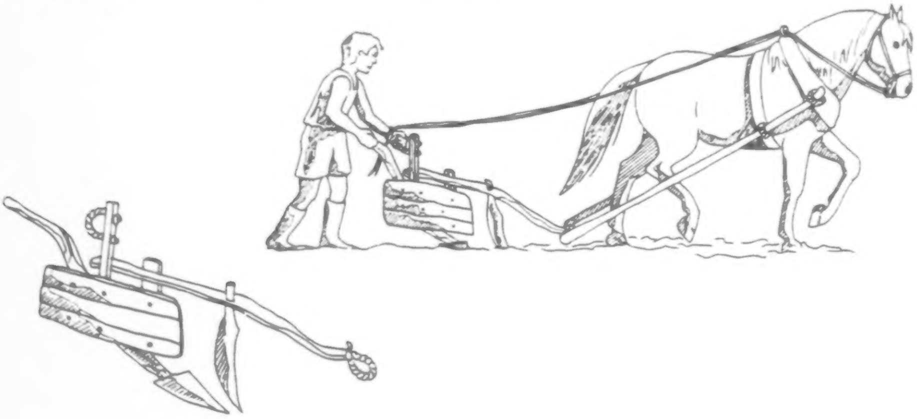
1. Listen as your teacher gives a brief description of the development and progression of tools. Now close your eyes and imagine that you have gone through a time warp and you find yourself sometime in the past before the year 1400. Write down what time frame you are in and the job you want to do. Are you farming? Are you building furniture without nails? Do you need to trap an animal for food and fur for clothing? Do you need to cut trees or brush for shelter? Do you need to make a sled to pull heavy objects? Do you need to get information to someone? Do you need to transport water?
2. On the same paper that you described the work you want to do, draw the tool or device (or combination of tools) you would invent to accomplish the job *and* give a written description of your device. In your written description, include the type of materials you would use and why you think your device would make the job easier. Remember, you can use the knowledge that you have, but you can only use the resources of the time. They do not have electricity.

3. Turn in your paper to your instructor. Discuss the impact of technology on society. Compare our technological society to other cultures that are not technologically advanced. What is the difference between countries with advanced tools and machinery and countries with limited technologies? Does technology make a difference in the economy of a country?

Evaluation
You will be graded on the problem you presented as an early human and the solution you created. As in all classroom situations, behavior and participation are considered.







INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 22
(2-3 WEEKS)

ARE SIMPLE MACHINES REALLY SIMPLE?

Essential Elements: 75.50(b): 2C, 2D, 4A, 4B, 5A, 5B, 6A, 6B, 7A, 7B, 8A, 8B
75.50(f): 1, 2, 14, 17

TAAS Objectives: Language Arts: WC 1, 4, 5; RC 2, 3, 5, 6, 7
Mathematics: C 2-4; O 1-4; PS 2, 3

Activity Overview

This activity will provide students with the opportunity to learn about simple machines. They will select materials from those supplied, and design and construct a "Rube Goldberg" machine to perform a specified function.

Challenge Statement

One thing that distinguishes us from the animals is our use of tools and machines. Over the years, tools have evolved from simple stones to complex machines with dozens of working parts.

Machines have a great effect on our daily lives. From a can opener to an automobile, all machines are variations or combinations of simple machines. Understanding simple machines and their combinations helps us to develop machines to perform needed tasks.

This activity will provide students with the opportunity to learn about simple machines through reading, application of related math and physics relationships, and manipulation of simple machines. They will then select materials from those supplied and design and construct a "Rube Goldberg" machine to perform a specified function. According to *Webster's Ninth New Collegiate Dictionary*, Rube Goldberg is defined as "accomplishing by complex means what seemingly could be done simply."

Systems Model

Resources
Students as inventors, designers, and engineers
Teacher as resource person and motivator
Structural material for machine parts
Machine and hand tools for parts production

Processes
Research and design of simple machines and Rube Goldberg inventions
Assembly and production of machine
Presentation of machine
Evaluation of machine

Applications
Mathematical formulas and relationships expressing physical laws
The evolution of simple machines and tools of the past
The use of machines in everyday life
The use of machines in industry

Impact

Creating inventions to answer a need and perform a task

Understanding the benefit of technology on society through the personal and industrial use of machines

Interfacing with Other Disciplines

Mathematics: Students will use measurements, fractions, ratios, proportion, and scale, to design and build their simple machines.

Science: Students will build simple machines using inclined planes, levers, wheels and axles, pulleys, gears, and screwthreads, and will apply material properties such as gravity and friction.

Language Arts: Students will use written and oral communication, technical writing (summary technical report), dictionary, and other research materials to complete the project.

Social Studies: Students will study the use and effect of machines on society, both past and present.

Critical Thinking Skills Reinforced

After fact finding and observing the properties of simple machines, the students will analyze, organize, and apply the information to the task and materials available, to design and construct a machine that will solve a problem. The students will then report to the class their findings both orally and visually. They will evaluate all the machines and reports for creativity and accuracy.

Teaching Tips

1. Quickly review the evolution from tools to machines. Point out that machines combine the function of many tools to complete a task more quickly and efficiently.
2. Demonstrate simple machines using any of these:
    a. a purchased demonstration kit on simple machines
    b. teacher-made models
    c. previously made student models

    Students should each demonstrate competence and understanding of the mathematical and physical principles in simple machines before designing their machine. Individual worksheets on which they work problems and answer questions may help to evaluate the level of individual understanding after the presentations and demonstration of machines, but prior to design and construction.
3. Explain the Rube Goldberg concept. Students probably are not familiar with his work. It is helpful to provide books or pictures of his machines to acquaint the students with the type of machines for which he is famous and to demonstrate the definition of a Rube Goldberg machine. The material should be presented in a way which does not stifle their creativity and result in their trying to duplicate parts of his machines. Part of the solution may lie in the materials provided; for example, many of his machines rely on living animals, fires, etc., which will not be available to students. **The emphasis should be on the definition, which emphasises the use of a complicated, overdone mechanism to perform a simple task!**
4. Divide the class into groups. Assign the problem.
5. Provide a materials kit to each student or team. Point out some of the materials to trigger their imaginations in design. Suggested items include the following (but please be creative in adding other useful (?) items!).

    Popsicle sticks
    Balloons
    Rubber bands
    Nuts, bolts, washers
    Shoestrings
    Belts (for vacuum cleaner, etc.)
    Simple gears (or patterns)
    Screws and nails
    Fabric/leather strips
    Paper clips
    Wheels

Film containers (empty 35mm)
Plastic spoons
Rubber or plastic tubing
Straws
Pieces of plywood
"Bushing" materials
Hinges
Clothespins
Corks
Orange juice can lids
Funnels (or patterns)
Toothpicks
Playing cards
Roofing (tin) washers
Springs
Feathers
Plastic can lids (coffee, etc.)
Dowels (small, medium, and large diameter)
Tinkertoys (or large diameter wooden dowels to make your own
Structural material, such as 1/2" x 3/4" (or similar size) wood strips
Sheetmetal (1 sq ft)
Chain (1' length, etc.)
Sand (or water) to provide material with sufficient mass to activate various mechanisms
Lengths of PVC pipe or plastic tubing

6. Assist the students in writing their technical reports. The language arts teachers may be willing to allow the students to work on their reports in language arts class if they are writing reports during that time. She or he may also be willing to copy guidelines for technical writing to give to your students.
7. Emphasize creativity and accuracy in the evaluation process. Point out that one problem can have several workable solutions, based on the number of machines presented.
   - Students will need some prior knowledge and experience in the use of machines, drafting, assembly, etc. Emphasize safety around machines.
   - An option would be to allow students to supplement the kit of supplies with their own materials. This would allow for more creativity, but would also put students without the financial means at a disadvantage. Limiting the materials to those which are given to all students also provides the experience of working within a set of "constraints" which is a "real-world" experience.
8. Discuss the future of the development of complex machines stemming from the simple machines the students designed. Transportation would be a good area to discuss.

Instructional Strategy

The activity is well suited to group or cooperative learning. The initial study of simple machines could be done as a cooperative learning activity by assigning students to be members of a "study" group and also of a "work" group. Groups may be formed by dividing the students into initial groups (A through E, for example) and then assigning each student a number (1 through 6, for example). The study groups could each investigate one type of machine, develop a "lesson plan" and have each student build demonstration materials for that machine type. (Each work group would then be formed by including all the students from each study group who have a specified number.) Each member in the work group would then teach other group members about the machine type he or she has studied, using the prepared materials. Each student would be responsible for presenting a lesson to his group, but would have the advantages of group development of materials to help ensure consistency of content and presentation. The design and building of the machines could also be a group activity, but would probably work best in small groups of two or three students each.

Equipment/Supplies

1. A materials kit provided to each student or team as listed above in Teaching Tips.
2. Production equipment and tools (possibly scroll saw, drill press, sander, hammer, hole punch, stapler, scissors)
3. Staples, tape (duct, electrical, transparent, masking), sandpaper, glue, paint

Evaluation Key

The evaluation process should include evaluation of student performance at all cognitive levels. Basic skills evaluation may take the form of written responses to questions or problems, observing the student demonstrating and describing the use of a simple machine to other students, and providing the student an opportunity to recognize simple machines which are incorporated into everyday tools or appliances.

Higher levels of cognitive learning may be evaluated by observing the application of physical principles in the design process, and rating student performance in tasks such as planning, designing, detecting or predicting problems in the design, modifying and revising the design or plans, and appraising the work of him/herself and other students.

Teacher evaluation: The teacher evaluation should consider student progress in several areas:

a. the correctness and communication value of the design sketches
b. completion and accuracy of the Bill of Materials
c. whether the machine meets the required design criteria such as minimum number of mechanisms present, function of the machine, effective use of materials, and appearance or quality of construction
d. demonstrated knowledge and skill in using mathematical relationships and physical properties to obtain desired machine results and in solving written exercises

Peer evaluation: His or her fellow students may also be given the opportunity to evaluate other students' machines using the same criteria. *Note:* A sample evaluation checklist is provided. However, the teacher may wish to modify the checklist so that the students evaluate only the machine performance, presentation, overall appearance, etc., without asking students to evaluate other students' Bill of Materials or sketches. The checklist may be expanded for each student to use in evaluating his/her own machine by adding the questions listed below under student evaluation to the form.

Student evaluation: The student should be encouraged (required?) to evaluate his/her own machine and answer questions such as:

a. Did my machine perform the desired task?
b. Does my machine "match" the design that I drew (and/or modified) and the Bill of Materials?
c. If I were to do the same unit again, what changes would I make in the procedure followed, materials used, or the design in general?

A checklist is appropriate for almost all of the above considerations. The teacher can assign percentages of the grade which will be assigned to teacher evaluation, student evaluation, etc., and then provide a checklist with maximum point values or grading scales for each subarea. It is also helpful to provide a space for comments beside each of the subareas for the teacher or student to state a reason for the score assigned (such as "excellent appearance and paint" or "joint does not work properly"). Students (and teachers!) may evaluate or judge more objectively when they have a set of specific criteria to look for and must justify the scores.

Support Materials

1. Dictionary
2. Encyclopedia entries, including Rube Goldberg, machines, levers, wheels, gears, inventions, Industrial Revolution, etc.
3. Keller, Charles, comp. *The Best of Rube Goldberg*. Englewood Cliffs, N.J.: Prentice-Hall, 1979.
4. Macauley, David. *The Way Things Work*. Boston: Houghton Mifflin, 1988.
5. Olivo and Olivo. *Fundamentals of Applied Physics*. 3rd ed. Albany, N.Y.: Delmar, 1984.
6. Physics texts (introductory)

7. Smith, Howard Bud. *Exploring Energy*. South Holland, Ill: Goodheart-Willcox, 1985.

Modifications for Handicapped, Disadvantaged, and LEP Students

LEP students may need help initially to understand the assignment and challenge. Working in a group setting will allow students with physical disabilities to work at their level with peer assistance.

Name_______________________

Bill of Materials

Qty.	Size	Description of item	Drawing needed?	Unit cost	Cost

Engineering Change Notice

Project ____________________

Engineer/designer ____________________

Part **Problem description** **Proposed change and reason**

Drawing or diagram (revision of original part drawing)

Approval signatures:

____________________ Engineer	____________________ Instructor
____________________ Date	____________________ Date

Rube Goldberg Machine Instruction Sheet
Balloon Bursting Machine

Goal

To build a Rube Goldberg type of machine that will "pop" a balloon as the final action of the mechanism.

Specifications

1. The machine will have at least four mechanisms (such as levers, gears, belts, etc.) that operate.
2. The machine will be mounted to a base or be capable of supporting itself.
3. The machine will use a wide variety of materials, selected for their application because of their properties.
4. The machine will be within the size guidelines provided by the instructor. It should be no larger than 15" by 15" by 10" high.
5. The student will provide the initial energy to start the mechanism, but the machine should then "run" continuously and "pop" the balloon using the last mechanism in the machine. The location of the balloon in relation to the machine will be given by the instructor.

Procedure

1. You should be familiar with simple machines and the definition of a Rube Goldberg machine.
2. You should look through the set of materials provided by your instructor to determine possible uses to build the desired mechanisms.
3. Using graph paper, sketch a machine (overall) that will accomplish the task. Make the sketch to scale so that approximate machine part dimensions can be determined.
4. Draw (draft or sketch accurately) the various machine parts that must be made.
5. Make a bill of materials listing all materials used, their quantities, and sizes.
6. Build the machine. If you discover a problem in your design during the construction phase, write a description of the problem on the Engineering Change Notice form.
7. Test-run the machine, and "fine-tune" any mechanisms as needed.
8. Write a summary technical report explaining the design and construction process you used.
9. Demonstrate the machine to the class.

Evaluation

A form will be provided (checklist and scoring instructions) on the day that the machines are demonstrated. You will be evaluating your machine as well as those of your classmates.

Rube Goldberg Machine Instruction Sheet
Marble Transport Machine

Goal

To build a Rube Goldberg machine that will transport a marble from the starting point to the finish point.

Specifications

1. The machine will have at least four mechanisms (such as levers, gears, belts, etc.) which operate. The mechanism must directly or indirectly transport the marble through the path.
2. The machine will be mounted to a base or be capable of supporting itself, and be aligned such that it will carry the marble successively through the mechanisms from start to finish.
3. The machine will use a wide variety of materials, selected for their application because of their properties.
4. The machine will fit within the frame provided by the instructor. Dimensions of the frame (inside) will be 15" by 15" by 10" high. The starting and ending points will be given on the drawing of the frame provided by the instructor.
5. You may provide the initial energy to start the mechanism, but the machine should then "run" continuously to deliver the marble.

Procedure

1. You should be familiar with simple machines and the definition of a Rube Goldberg machine.
2. You should look through the set of materials provided by your instructor to determine possible uses to build the desired mechanisms.
3. Using graph paper, sketch a machine (overall) which will accomplish the task. Make the sketch to scale so that approximate machine part dimensions can be determined.
4. Draw (draft or sketch accurately) the various machine parts which must be made.
5. Make a bill of materials listing all materials used, their quantities, and sizes.
6. Build the machine. If you discover a problem in your design during the construction phase, write a description of the problem on the Engineering Change Notice form.
7. Test-run the machine, and "fine-tune" any mechanisms as needed.
8. Write a summary technical report explaining the design and construction process you used.
9. Demonstrate the machine to the class.

Evaluation

A form will be provided (checklist and scoring instructions) on the day that the machines are demonstrated. You will be evaluating your machine as well as those of your classmates.

Name______________________________
Machine #___________________________

Rube Goldberg Machine Evaluation Sheet

For each category listed below, evaluate your or your classmates' machine, and circle the number that best represents how well the machine meets the requirements. In the space, "Comments," you may write why you assigned the score that you did (for example, "good workmanship on hand-made gears" or "very creative use of materials").

SCORE	**ITEM**	**COMMENTS**
No Yes		
2 4 6 8 10	Machine has four mechanisms as specified.	
2 4 6 8 10	Machine is correct size as specified.	
2 4 6 8 10	Machine uses a wide variety of the materials provided (and *only* the ones provided).	
2 4 6 8 10	Materials are chosen well for their properties and applications in the machine.	
3 6 9 12 15	Machine carries out the assigned task correctly.	
2 4 6 8 10	Sketches and drawings are correct and clearly describe the machine.	
2 4 6 8 10	Bill of Materials correctly lists each material used, size, quantity, etc.	
2 4 6 8 10	The machine is well built, carefully constructed, and neat in appearance.	
3 6 9 12 15	The student clearly explained and demonstrated the machine to the class.	

Add the assigned number in each category. There are 100 possible points.

______________ **Total Score**

ARE SIMPLE MACHINES REALLY SIMPLE?

Learn about simple machines by designing and constructing a Rube Goldberg machine to perform a specified function.

Challenge Statement

One thing that distinguishes us from the animals is our use of tools and machines. Over the years tools have evolved from simple stones to complex machines with dozens of working parts.

Machines have a great effect on our daily lives. From a can opener to an automobile, all machines are variations or combinations of simple machines. Understanding simple machines and their combinations helps us to develop machines to perform needed tasks.

From our understanding of the simple machines of today, we will develop the complex multiuse machines of the future.

Objectives

- To understand and demonstrate the use of simple machines, including the inclined plane, lever, wheel and axle, and pulleys
- To use sketching techniques to communicate or represent the design of your "complex machine"
- To build a machine to perform a stated task
- To understand and use simple machine principles to build a more complex machine
- To communicate orally and in writing to describe the design and construction process and your finished machine

Vocabulary/Concepts Reinforced

- Inclined plane
- Efficiency
- Fulcrum
- Classes of levers
- Force
- Belt
- Wedge
- Lever
- Effort
- Force
- Gear
- Friction
- Wheel and axle
- Pulley
- Distance
- Mechanical advantage
- Rotary motion

Equipment/Supplies

- A materials kit containing items supplied by the teacher
- Production equipment and tools, such as a scroll saw, drill press, sander, hammer, hole punch, and stapler
- Staples
- Tape (duct, electrical, transparent, or masking)
- Sandpaper
- Glue
- Paint

Introduction

Mechanical systems or machines are made of parts that move. The ways in which machines work are governed by laws of nature. The design of complex machines involves understanding the ways that simple machines work. The simple machines can then be combined into larger systems that produce the correct amount of movement and force to do the desired task.

In this activity, you will learn about simple machines and their operations, and use that knowledge to build a machine. Your machine should use a variety of mechanisms chosen from items such as carrying mechanisms, pulleys, gears, levers, wheels, and similar devices. It should be designed to perform a specific task (given by your instructor).

Procedure

1. Go back to the tools of early humans beginning with stones. Follow the evolution of tools to the invention of machines. "What is the difference between a tool and a machine?"
2. Read the material provided on each of the simple machines, and perform the activities described.
3. Read the material provided on Rube Goldberg and his inventions. Look through the set of materials provided by your instructor, and brainstorm to identify ways each item or material could be used. Read the goal statement for the machine, and be sure that you understand the task (what your machine is supposed to do).
4. Using graph paper, sketch a machine (to the correct proportion or scale). You may need several sketches to fully describe the machine. Be sure that you determine correct sizes and distances so that connecting parts will fit correctly. Make a drawing of each part you need to build.
5. Make a Bill of Materials, including a list of the parts you will use, the size of each, and the quantity of each needed.
6. Build the machine. If you discover a problem in your design during the construction phase (something does not work the way you intended, for example), write a description of the problem and any changes you make in the design on the Engineering Change Notice form. (Your instructor may require that you explain the changes and get his or her approval or initials before modifying your design.) Test-run the machine. Perform any fine-tuning or adjustments needed.
7. Write a summary technical report describing the design and construction processes you used. (Your instructor may want you to include photographs taken during the design and construction process.)
8. Demonstrate and explain the function of your machine to the class.
9. Answer the questions on the Rube Goldberg Machine Evaluation Sheet.
10. Discuss the types of machines that will evolve in the future. What will our needs be? What kind of transportation will we have? How will we farm? How will our lives change with the future development of machines in technology?

Evaluation

You will be evaluated three ways.

Teacher evaluation: Your teacher will evaluate your progress through the unit by considering the following areas:

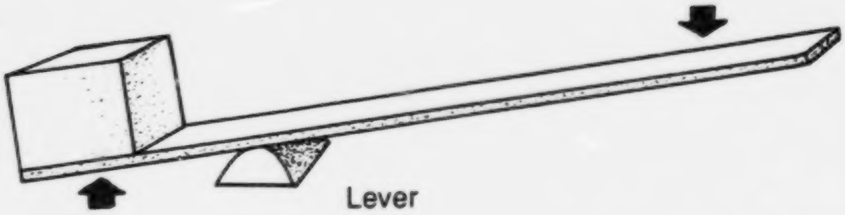
1. the correctness and communication value of your design sketches
2. completion and accuracy of your Bill of Materials
3. whether your machine meets the required design criteria, such as minimum number of mechanisms present, function of the machine, effective use of materials, and appearance or quality of construction.

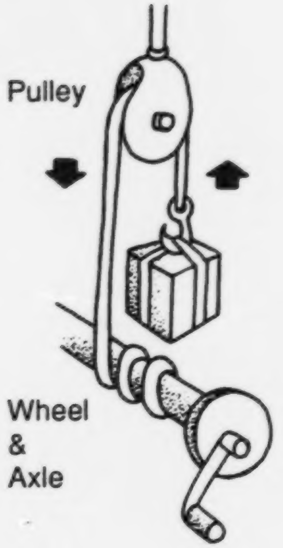
4. demonstrated knowledge and skill in using mathematical relationships and physical properties to obtain correct machine operation and in solving written exercises

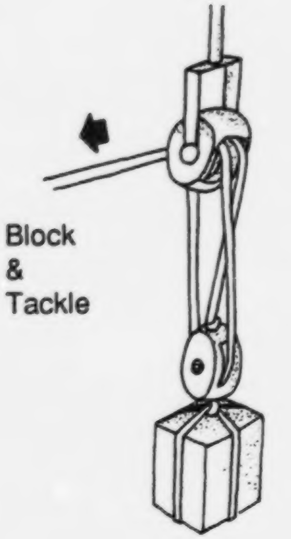
Peer evaluation: Your fellow students will have the opportunity to evaluate your machine on the Rube Goldberg Machine Evaluation Sheet.

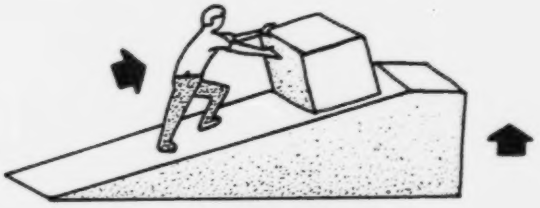
Self-evaluation: You should evaluate your own machine according to the Rube Goldberg Machine Evaluation Sheet. On a separate sheet of paper, answer this question:

> If I were to do the same unit again, how would I change (1) the procedure followed, (2) the materials used, or (3) the design in general?

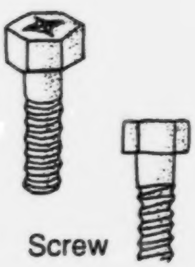


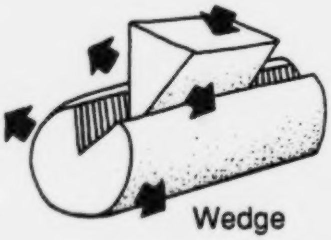

Pulley
Wheel & Axle


Block & Tackle



Inclined Plane





INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 23
(3-10 DAYS)

HYDRAULICS

Essential Elements: 75.50(b): 4A, 4B, 6A, 6B, 6D, 8B
75.50(f): 8, 10, 11

TAAS Objectives: Language Arts: RC 1-5; WC 1, 2
Mathematics: C 2, 4; PS 3, 4

Activity Overview

This activity will introduce the student to fluid systems in general and hydraulic systems specifically. It includes a written introduction to fluid systems, components of hydraulic systems, fluid characteristics and requirements, and common applications of hydraulic systems. Also included are instructor demonstrations and a student activity to monitor the effects of selected fluids on various materials.

Challenge Statement

A fluid system is one that uses fluids under pressure to transmit power. There are two types of fluid systems, hydraulic and pneumatic. Both systems are commonly used in industry, business, and home applications. Students need to be familiar with the components and design of systems, characteristics of systems, their advantages and limitations, and how to use fluid systems safely.

Systems Model

Resources
Students as engineers and observers
Teachers as demonstrator and monitor
Tools, supplies, and equipment to demonstrate hydraulics

Processes
Learning new concepts about hydraulics
Demonstrating hydraulics
Observing hydraulics experiments
Recording observable results
Analyzing results

Applications
Math skills to hydraulics
Hydraulic concepts to machinery and equipment

Impact
Understanding hydraulic machines and equipment
Design and invention of hydraulic machinery and equipment

Interfacing with Other Disciplines

Language Arts:	Students will learn new terms and concepts. They will record observations.
Mathematics:	Students will use measurement, fractions, and ratios to understand hydraulics.
Science:	Students will use basic principles of pressure, force, and chemical reactions in hydraulic experiments.

Social Studies:	Students will realize the impact of hydraulic machines and equipment on industry and society.

Critical Thinking Skills Reinforced

Knowledge:	Vocabulary and knowledge of applicable mathematics processes
Comprehension:	Recognizing and matching information about a system to the related equations and formulas, answering questions about reading material
Application:	Using formulas and math processes to solve problems
Analysis:	Understanding the relationships between area of piston, force obtainable, and distance traveled in a system

Teaching Tips

1. This activity includes reading, math applications, and the need for the student to understand theory at a level that may be difficult for students with limited abstract reasoning. It may require more assistance from the teacher or peer tutors for some students.
2. It may be helpful to have a demonstration tool of a "system" with two syringes of different diameters connected by tubing or a hose and filled with liquid. The student can see the differences in the amounts that the different size pistons move relative to each other.
3. This activity includes several instructor demonstrations performed prior to the student reading the material and completing the student activity. These demonstrations include:
   a. Liquids are relatively incompressible. To demonstrate this, obtain a small baby aspirin bottle (or similar small glass bottle) to the top with water. Force in a good cork. Strike the cork sharply with a hammer. The bottle will burst.
   b. Demonstrate Pascal's law by blowing up a balloon. Note that the resulting pressure is equal throughout; every square inch of the balloon is subject to an equal force because of the air pressure. You may also demonstrate Bernoulli's principle: the higher the speed of a flowing liquid, the lower the pressure. When the balloon is let go in the room, the air leaving the balloon is moving at a higher speed than that at the front of the balloon, so that the pressure on the front of the balloon is greater, forcing it to move in the room.
   c. Examples of such items as a hydraulic jack, door closer, and shock absorber can be demonstrated. (The book *The Way Things Work* or similar books contain illustrations of a variety of hydraulic units and applications.)

Instructional Strategy

- Where possible, students may be involved in the above demonstrations.
- The example in the student worksheet may be worked for the class to provide further explanation. Student interaction in working through the arithmetic steps will provide the opportunity to assess student understanding and point out errors or misunderstanding before the student works other problems independently.
- When analyzing the effects of liquids on materials, it may be helpful to place the eight jars at various locations around the room. Divide the class into eight groups, and have the groups rotate to the various jars and record the results.
- Students are probably aware of other systems that use hydraulics and may be encouraged to research or investigate other systems related to their areas of interest (on cars, tractors, dentist or hair salon chairs, etc.)
- Students may be asked to spend one or two days outside class looking for and making a list of other systems that use fluid systems. The class can then collectively produce a list.

Equipment/Supplies

At least eight samples of each material listed should be available since each will be tested with eight different liquids.

1. Cast iron
2. Lead
3. Rubber
4. Quart jars
5. Brake fluid
6. Hydraulic fluid

7. Brass
8. Aluminum
9. Steel
10. Nylon
11. Copper
12. Water
13. Permanent antifreeze
14. Rust inhibitor
15. Automatic transmission fluid
16. Nondetergent motor oil

Evaluation Key

The student report sheet (listing results from the material testing) should be graded. The student should clearly describe the effect of the liquid on the material, using well-chosen, descriptive words, and correct spelling and terminology.

Answers to the questions in the reading material are given below:

(1) H(S) = 9 inches
(2) H(L) = 1 inch
(3)

	Area (S)	Area (L)	$\frac{\text{Area (L)}}{\text{Area (S)}}$	$\frac{\text{Height (L)}}{\text{Height (S)}}$
Example	12.56	50.24	$\frac{50.24}{12.56} = 4$	$\frac{2}{8} = \frac{1}{4}$
Problem 1	3.14	28.26	$\frac{28.26}{3.14} = 9$	$\frac{1}{9} = \frac{1}{9}$
Problem 2	28.26	452.16	$\frac{452.16}{28.26} = 16$	$\frac{1}{16} = \frac{1}{16}$

(5) 9; 9
(6) 16; 16
(7) Answers will vary, but should state that the larger the piston, the less distance it will move in response to the movement of another piston in the system.
(8) True
(9) False
(10) True

Support Materials

1. Bohn, R.C., and MacDonald, A.J. *Power: Mechanics of Energy Control.* 2nd ed. Bloomington, Ill: McKnight, 1983.
2. Olivo, C. Thomas, and Olivo, Thomas P. *Fundamentals of Applied Physics.* 3rd ed. Albany, N.Y.: Delmar, 1984.
3. Macaulay, David. *The Way Things Work.* Boston: Houghton Mifflin, 1988.

Modifications for Handicapped, Disadvantaged, and LEP Students

Students with limited academic skills in reading or mathematics and those with limited abstract reasoning skills will probably need more assistance, either from the teacher or from peer tutors.

HYDRAULICS

Learn about fluid systems, and especially hydraulic systems, by watching demonstrations, reading, and performing an experiment to determine what materials do when they are in contact with certain liquids.

Challenge Statement

Fluid systems are used in many industrial, business, and home applications. They can perform actions similar to those of mechanical systems (with gears, pulleys, etc.), but typically have few moving parts. The fluid inside the containers is used to transmit power. You should be familiar with the parts and design of systems, their advantages and limitations, and how to use fluid systems safely. As a consumer, you will use devices with fluid systems.

Objectives

- To know the meaning and correct use of the vocabulary words listed
- To know the two types of fluid systems
- To know the basic components of a hydraulic system
- To know properties of liquids and the laws which apply to them
- To list examples of simple hydraulic applications
- To be able to solve simple system design problems

Vocabulary/Concepts Reinforced

- Fluid
- Gas
- Pump
- Lubrication
- Viscosity
- Pressure
- Hydraulic
- Liquid
- Medium
- Corrosion
- Emulsion
- Porous
- Pneumatic
- Reservoir
- Contaminants
- Oxidation
- Compressible

Equipment/Supplies

- Cast iron
- Lead
- Rubber
- Brass
- Aluminum
- Steel
- Nylon
- Stainless steel
- Copper
- Quart jars (8)
- Brake fluid
- Hydraulic fluid
- Water
- Permanent antifreeze
- Rust inhibitor
- Automatic transmission fluid
- Multigrade motor oil
- Nondetergent motor oil

Introduction

The term *fluid* refers to a material that is in either a liquid or a gaseous state and is capable of flowing. A fluid system is one that uses fluids under pressure to transmit or control power. There are two types of fluid systems. *Hydraulic systems* contain liquids, while *pneumatic systems* use air or another gas as the fluid. The term *hydraulic* is based on the Greek word for water. The prefix "hydro" is used in words that refer to a process involving water.

A hydraulic system includes four main parts: a reservoir to store the liquid; a pump to push the liquid through the system; lines or hoses to control and transmit the liquid under pressure; and a cylinder or motor to change the fluid movement into work that is useful. The fluid in a hydraulic system is an essential part of the system.

Liquids have certain characteristics such as shapelessness, resistance to being compressed, and the ability to transmit force. It is important that the correct type of fluid be used and that it be kept clean by preventing dirt and other contaminants from entering the system. Keeping the fluid clean is important so that damage to pumps and cylinders is prevented and valve leaks do not occur. Dirt which does get into the system can be caught in a filter containing a strainer, screen, or layers of porous paper.

When choosing a fluid for use in a hydraulic system, follow the equipment manufacturer's instructions. Although the most common medium is oil, many other types of liquids are available with a variety of properties. (Be sure that you understand the meaning of the word *medium* as it is used in this paragraph.)

Warning: Brake fluid must never, under any circumstances, be used in a hydraulic system designed to use petroleum-based oils, as it is not a petroleum-based product and will cause problems in the system.

Even the correct oil in a carefully maintained system will eventually break down or lose its properties. Oil and other fluids in hydraulic systems must be completely changed regularly, according to the manufacturer's recommended instructions. As an example, the oil and transmission fluid in your family car must be changed at regular times.

Some of the important properties of oil and fluids are listed and described below.

1. Viscosity refers to the way the oil flows or allows objects to move through it. A high viscosity liquid seems "thicker" than a low viscosity oil (for example, pancake syrup is thicker than water). Using oil as an example, operating under very cold conditions requires a lightweight oil, while a heavy oil must be used in high temperatures to prevent the oil from breaking down.
2. Resistance to oxidation is important. Many materials react chemically with oxygen. Rust is formed when steel reacts with oxygen. In most cases, we try to prevent oxidation because it changes the way the material functions.
3. The way a liquid behaves when it contacts water is important. Many oils form an emulsion with water. The emulsion may become thick, sticky, and gummy and cause problems in a system. Unless specified by the manufacturer, water should not be allowed to mix with the oil.
4. Fluids need to be chosen to prevent corrosion, which is another chemical reaction similar to oxidation. Corrosion occurs when different materials react with each other, destroying the material.

In addition to having the properties listed above, the main purpose of hydraulic fluid is to transmit force. Some of the advantages of hydraulic systems are that they can replace systems of gears, belts and pulleys, cams, etc., have low maintenance needs, have built-in lubrication, and can transmit power up, down, around corners and over relatively long distances without loss in efficiency.

Scientists have discovered many laws which govern how fluid systems operate. Blaise Pascal (1623-1662) discovered that a fluid in a container applies pressure in all directions equally. Pascal's law is used often in designing hydraulic systems.

Figure 1 shows a simple hydraulic system. The system includes two pistons, each in a cylinder, and a connecting pipe or hose. The bottom of each cylinder (beneath the piston) and the connecting pipe are completely filled with liquid. When one piston is moved down, the liquid is forced out of that cylinder, into the pipe, and then into the other cylinder, forcing the second piston to move upward.

Figure 1 shows two pistons (large and small) in cylinders. The radius measurements of the pistons are labeled *R(S)* for the small piston and *R(L)* for the large piston. The heights that each piston move are labeled *H(S)* for the small piston and *H(L)* for the large. In order to determine the effect of moving one piston on the other, use the following procedure.

1. Since the system is filled with liquid (which is not easily compressed), pressing down on one cylinder should force fluid out of the cylinder, through the pipe, and into the other cylinder, causing that piston to rise. The volume of the liquid that is forced out of the cylinder is the important factor. Volume in a cylinder is calculated by the following formula:

   V = A × H with A = cross-sectional area and H = height

   Area of a circle is calculated using the formula:

   A = *pi* × R × R with *pi* = 3.14 and R = radius.

2. Write an equation that says that the volume of liquid leaving one cylinder must equal the volume of liquid forced into the other cylinder. Written in words, the equation looks like:

   Volume forced out of cylinder 1 = Volume forced into cylinder 2

   Substituting the formula obtained in step 1 for volume into each side of the word equation gives the formula:

   Area(S) × H(S) = Area (L) × H(L)

3. Read and work through the example given below. Be sure that you understand how to substitute the values for radius and height into the equation. After you understand the example, work the problems given.

   If R(S) = 2 inches, H(S) = 8 inches, and R(L) = 4 inches, find the value of H(L). In order to use the equation in step 3 to find H(L), we need to calculate the other three values using the information given. Then we can use arithmetic to find the missing value.

   First, find the area of each cylinder:

   Area(S) = *pi* × R(S) × R(S) and Area(L) = *pi* × R(L) × R(L)
   = 3.14 × 2 × 2 = 3.14 × 4 × 4
   = 12.56 = 50.24

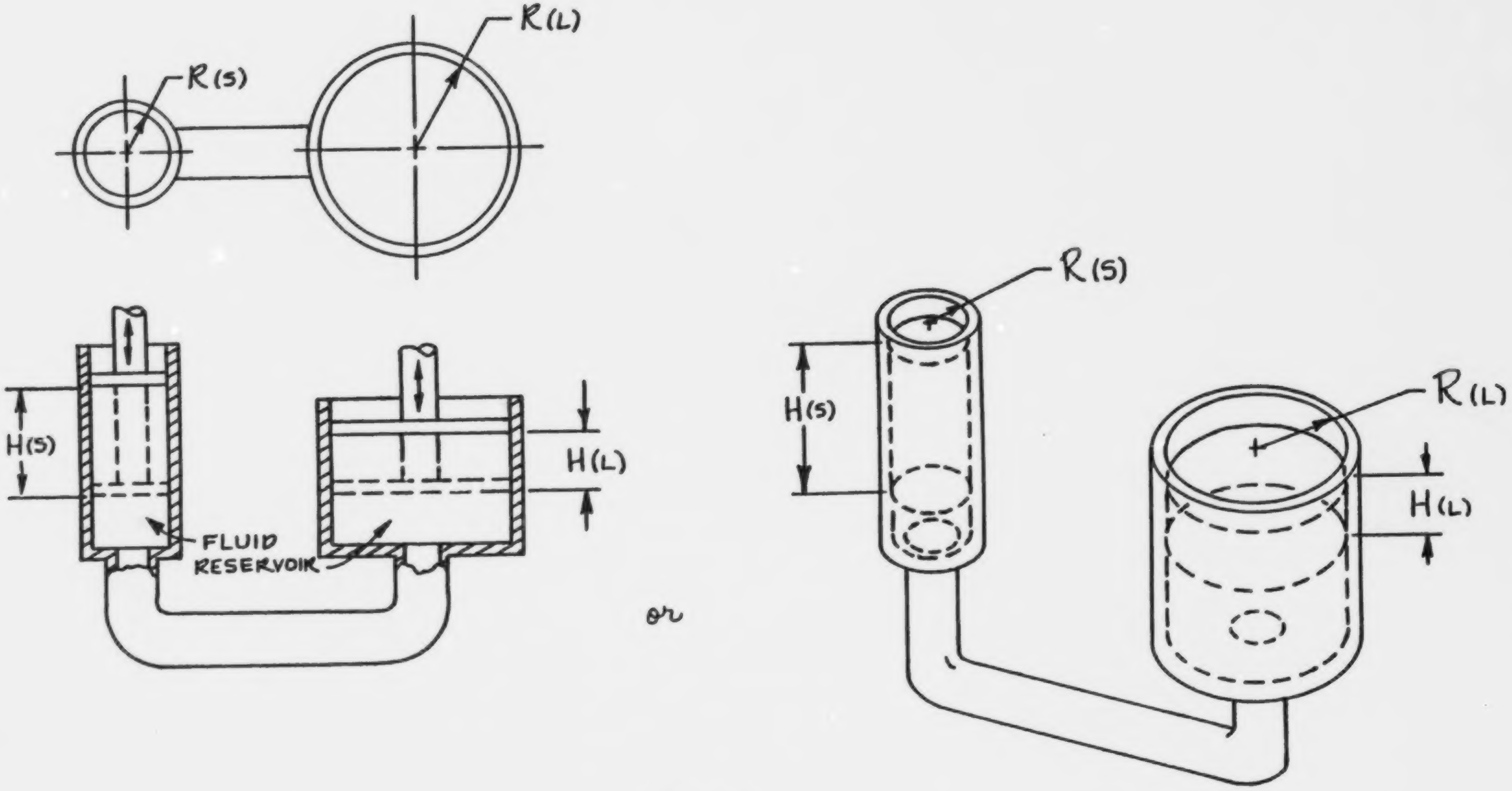

R(S)
R(L)
H(S)
H(L)
FLUID
RESERVOIR
or
R(S)
H(S)
R(L)
H(L)

Figure 1

Substitute the known values into the equation from step 2:

12.56 sq.in. × 8 inches = 50.24 sq.in. x ___ inches
100.48 cu.in. = 50.24 × ___ cu.in. If 100.48 = 50.24 × ____, we can divide 100.48 by 50.24 to get the missing value of 2.

Problems

(1) If R(L) = 3 inches, H(L) = 1 inch, and R(S) = 1 inch, find H(S).
(2) If R(S) = 3 inches, H(S) = 16 inches, and R(L) = 12 inches, find H(L).
(3) Complete the chart below, filling in the data from the example problem and the problems that you solved. Then answer the questions.

	Area (S)	Area (L)	Area (L) / Area (S)	Height (L) / Height (S)
Example			______ =	______ =
Problem 1			______ =	______ =
Problem 2			______ =	______ =

(4) In the example problem, the area of the larger cylinder is ____ times as large as the area of the smaller cylinder. The distance that the smaller piston moved (height) is _____ times as large as the distance the large piston moved.
(5) In problem 1, the area of the larger cylinder is ____ times as large as the area of the smaller cylinder. The distance that the smaller piston moved (height) is _____ times as large as the distance the large piston moved.
(6) In problem 2, the area of the larger cylinder is ____ times as large as the area of the smaller cylinder. The distance that the smaller piston moved (height) is _____ times as large as the distance the large piston moved.
(7) Explain the relationship (or "trade-off") between the area of a piston and the distance it moves in a hydraulic system. Be specific and clear in your answer.

A characteristic of hydraulic systems is that the force that is applied or the load that can be lifted by a piston increases as the area of the piston increases. Reread the last sentence and be sure that you understand it. Then write a T beside each statement below which is true and an F beside each statement which is false.

(8) In a hydraulic system with two pistons, the larger piston can apply more force or lift heavier loads, but the larger piston will not move as far as the smaller piston.
(9) In a hydraulic system with two pistons, the larger piston can apply more force or lift heavier loads and the piston will move farther than the small piston does.
(10) You can use a hydraulic system to apply more force from the second piston than you apply to the first piston by making the second piston larger than the first.

Procedure

To show how certain compositions of liquids affect different materials, set up the experiment, which will be observed for two weeks. This experiment should show that some materials are not compatible with certain liquids. Therefore, certain materials should be used to carry the liquid, or certain additives must be added to the liquid to prevent corrosion and deterioration in cooling systems, hydraulic systems, brake systems, transmission systems, and engine systems.

1. Follow the instructions carefully. Be sure to follow safety rules and wear goggles, remove jewelry, and roll your sleeves above the elbow before handling the materials and liquids.
2. Fill quart jars halfway with liquid, and add pieces of each material to each jar. Place the lids on the jars loosely.
3. After five (5) days, remove the materials, and observe if any change has taken place. Record the results on the top part of the chart provided.
4. After noting the results, place the materials back in the liquid, and leave them there for another five (5) days. Remove the materials, and record any changes which have taken place. Write the results on the bottom of the chart.

Evaluation

Your teacher will grade the written exercise, including the problem solving and the chart showing the experiment results.

5-DAY CHECK

	Water	Anti-freeze	Rust inhib.	Brake fluid	Trans. fluid	Multigrade oil	Hydr. fluid	Nondeter. oil
Cast iron								
Rubber								
Brass								
Aluminum								
Steel								
Nylon								
Lead								
Stainless Steel								
Copper								

10-DAY CHECK

	Water	Anti-freeze	Rust inhib.	Brake fluid	Trans. fluid	Multigrade oil	Hydr. fluid	Nondeter. oil
Cast iron								
Rubber								
Brass								
Aluminum								
Steel								
Nylon								
Lead								
Stainless Steel								
Copper								

Which material/liquid combination seemed to be the worst?

Was there any materials that seemed to be okay in most or all of the liquids?

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 24
(3 DAYS)

COLLECTING, TRANSPORTING, AND PROCESSING RAW MATERIALS

Essential Elements:	75.50(b): 6D 75.50(f): 10, 12, 16
TAAS Objectives:	Language Arts: RC 1-4; WC 1, 2, 4, 6 Mathematics: C 1, 4; PS 3

Activity Overview

Your students will choose a raw material from a list that they brainstorm, research the raw material, chart the information, and share the information with the class.

Challenge Statement

Jeans, sunglasses, jewelry, and gasoline are only a small percentage of all the products we use. These products don't grow on trees as we buy them in the store. Nearly everything we buy is made of many different materials. If we break down the product to the materials that were mined, grown, or extracted, we would find the raw material that makes the product. For example, the material in your coat may have come from sheep or from under the ground. Many different materials must be transported to one place, then processed to give us the products we use.

By identifying the raw materials that make up the products we use, your students will develop a better understanding of the scope of the manufacturing industry and the interdependence of people necessary to make the process work.

Systems Model

Resources

Instructor as resource person and monitor
Students as researchers, planners, chart makers, and discussion members
Maps, charts, and reference materials

Processes

Brainstorming and discussion of raw materials and the processes of manufacturing
Research of raw materials
Recording information about raw materials and processes in chart form
Reporting the information about raw materials and processes to the class

Applications

Information about raw materials to the products we use
Information about raw materials to the manufacturing process
Information about transporting materials
Information about raw materials to the process of charting

Impact

Understanding the interdependence of people necessary to make the manufacturing process work
Career opportunities
Understanding the free enterprise system

Interfacing with Other Disciplines

Language Arts: Students will learn new vocabulary, do research, record, and report information about raw materials and processes.

Mathematics: Students will record information in chart form and determine mileage from interpreting the mileage scale on a map.

Science: Students will learn about raw materials and processes and read maps and charts.

Social Studies: Students will develop a better understanding of the scope of the manufacturing industry and the interdependence of people necessary to make the process work.

Critical Thinking Skills Reinforced

The students will be able to apply information they gather, and organize and report about the collection, transporting, and processing of raw materials to the products they use. This will give them insight into the scope of the manufacturing industry.

Teaching Tips

1. Lead the students through a discussion of products with emphasis on the raw materials necessary for production. You will probably need to help them break down the product and determine the processes used.
2. In order to have enough reference materials, you may need to take your class to the library for the day. The social studies and science teachers may be good resources for references on raw materials. Students may be given the opportunity to call local industries for additional information. It would be helpful to have a transparency of the Raw Materials chart to explain it before the students begin their research. Have copies of state, national, and world maps for the students to plot locations and determine distances.
3. Group the students according to their raw material. For example, all students who researched petroleum would be in a group, and students who researched iron ore would be in another. Have one student from the group share his or her information, then the others just report any additional information they have. This will save time.

Instructional Strategy

- Open the class with a discussion of familiar products and the raw materials and processes necessary to produce them.
- Have students choose a raw material to research and chart.
- Organize the supplies, and monitor the class.
- Close the class with student reports from their charts.

Equipment/Supplies

Equipment and supplies for this activity should be readily available in any school resource center. You will need to have enough state, national, and world maps for references (state almanacs, encyclopedias, etc.). You may also acquire additional maps from the state department of transportation or a local tourist business. You will also need encyclopedias for reference.

Modifications for Handicapped, Disadvantaged, and LEP Students

Students may need additional time and assistance in completing the Raw Materials chart.

Name________________________________

Raw Materials

My raw material is____.

The collection process is____.

Complete the following chart with information about your raw material. Give at least three options for each item.

	1	2	3
Locations of raw material			
This material is transported from the above location by...			
The nearest processing area is... What is the approximate distance, in miles, from the above location?			
This raw material is used for making…			
The types of processing used to make the above product is...			
The end product is transported by...			

When you turn this chart in, include a map indicating the three locations where your raw material is found.

COLLECTING, TRANSPORTING, AND PROCESSING RAW MATERIALS

Choose a raw material from a list that you and your class brainstorms, research the raw material, chart the information, and share the information with the class.

Challenge Statement

Jeans, sunglasses, jewelry, and gasoline are only a small percentage of all the products we use. These products don't grow on trees as we buy them in the store. Nearly everything we buy is made of many different materials. If we break down the product to the materials that were mined, grown, or extracted, we would find the raw material that makes the product. For example, the raw material for your coat may have come from sheep or from under the ground. Many different materials must be transported to one place, then processed to give us the products we use.

See how many raw materials your class can identify that make up the products we use.

Objectives

- To identify a large number of raw materials that make up the products we use
- To know the major locations of many raw materials and locate them on maps
- To identify the process needed to collect the raw materials
- To know the means of transporting raw materials
- To develop a greater understanding of the production process and the interdependence of people necessary to make the process work

Vocabulary

- Raw material
- Mileage
- Chart
- Scale
- Key
- Extraction
- Commodity
- End product
- Map
- Tanker
- Mining
- Drilling
- Interstate
- Most direct route
- Cargo plane
- Harvesting
- Intercontinental
- Pipeline
- Production process

Equipment/Supplies

- Maps
- Charts
- Encyclopedias

Introduction

The purpose of this activity is to help you realize the wide scope of the manufacturing process, all the way from collecting the raw material to producing the end product. We usually don't realize all that is involved in making a simple product. Let's look at something really simple like catsup. Tomatoes are trucked from California, sugar is grown and shipped by barge from Louisiana, and spices are shipped by boat or flown from the Orient. Also, sand for the glass bottle is extracted and processed at the coast, trees are cut and processed for the paper label, and tin is made into the cap.

With thought and discussion, you will be able to better understand the entire production process and the interdependence of people necessary to make the process work.

Procedure

1. With your class, brainstorm common products you use every day. List ten of them across the top of the board. Below each product, in columns, list the raw materials that are collected and processes needed to make the product.
2. Choose a raw material that was discussed the day before, research the material, and complete the Raw Materials chart. Work quickly. You have only one day to complete your work.
3. Locate the source of your raw material on a map. Discuss all the raw materials with the class.
4. Turn in your map and Raw Materials chart to your teacher.

Evaluation

You will be evaluated on your class participation and behavior during the discussions. You will also receive a grade on your Raw Materials chart and your map.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 25
(4 DAYS)

ENGINEERING MATERIALS AND MATERIAL PROPERTIES

Essential Elements: 75.50(b): 2A, 2C, 2D, 3A, 4B, 5A, 6A, 6D, 7B, 8B
75.50(g): 1A, 1B, 1F, 1I
TAAS Objectives: Language Arts: RC 1-6; WC 1-4
Mathematics: C 1; PS 1-4

Activity Overview

You will look at materials we use from the perspective of the user and the manufacturer. You will have the opportunity to realize the importance of using proper materials in production.

Challenge Statement

Why don't we all wear wooden shoes or sleep on straw mattresses? It seems ridiculous to even ask, but the answers bring up the types of characteristics that engineers and designers must consider for every product they make. Every product has certain uses that require material properties and characteristics for optimum use. New materials are being developed everyday to meet the needs of new products. The challenge is to match material properties with products.

Systems Model

Resources
Students as learners, engineers, and experimenters
Instructor as resource person and experimenter
Current events
Material necessary for lubricant experiment

Processes
Reading, studying and discussing new concepts
Analyzing and applying product use and material property needs
Conducting and evaluating lubricant experiment
Surveying innovations in materials development

Applications
New terms and concepts to everyday products
Science awareness to technology
Technology awareness to career awareness

Impact
Future technological developments
Career choices

Interfacing with Other Disciplines

Language Arts:	Students will learn new terms and concepts. They will analyze and apply products and material characteristics.
Mathematics:	Students will conduct an experiment using lubricants, time and record results, and make deductions from time records.
Science:	Students will understand how science and technology work together to make new products.

Social Studies: Students will understand how technology is researched and developed to benefit society. They will see career opportunities in technology.

Critical Thinking Skills Reinforced

Students will apply material properties to common products and realize the connection between materials and use. They will experiment with materials and draw conclusions from results. They can make career application in a highly innovative technological field.

Teaching Tips

1. Use available materials for the lubricant experiment. Set up a slope of glass, wood, or metal, and slide a weight down the slope (about 20°). Lubricate the slope with what is available. Have the students record the time for each. Make deductions.
2. Collect current events articles from technology publications. Review them with the students, and discuss materials that are used in the products.
3. Discuss career opportunities in materials research and development.

Instructional Strategy

- Provide students with information about engineering through reading and discussing the Introduction and Material Properties sheet.
- Present the problem of matching properties to product through the Material Characteristics Worksheet.
- Conduct the lubricant experiment to give the students a hand-on experience with lubricants.
- Question the students to lead them to conclusions about the importance of making proper material choices.
- Discuss career options in research and development.

Equipment/Supplies

1. Current events articles
2. Materials for lubricant experiment

Evaluation Key

Pistons

1. (+) impact strength
2. (+) compression strength
3. (+) heat resistance

Microwave cookware

1. (+) heat resistance
2. (+) thermal conductivity
3. (-) thermal expansion

Construction studs

1. (+) torsion strength
2. (+) compression strength
3. (+) strain

Firefighters' clothing

1. (-) water absorption
2. (+) heat resistance
3. (-) electrical conductivity

Windshields
1. (+) hardness
2. (-) water absorption
3. (+) opacity

Superconductors
1. (+) ductility
2. (+) electrical conductivity
3. (-) thermal expansion

The answers may vary somewhat.

Support Materials

1. Associated Press, "The Body Shop," *Austin American-Statesman*, May 10, 1992.
2. "Complex Problem-Solving. Materials Selection," *The Technology Teacher*, April 1991, 15-22.
3. "Engineering Materials," *The Technology Teacher*, December 1988, 15-22.
4. Wright, R. T. *Processes of Manufacturing*. South Holland, Ill.: Goodheart-Willcox, 1987.

Material Properties

Mechanical properties—the ability of a material to carry/resist mechanical forces/loads
Stress—force applied to material
Strain—change in the length of a material under stress
Tensile strength—maximum load a material can withstand before breaking
Compression strength—ability to resist forces which squeeze the material
Shear strength—ability to resist forces applied from different directions
Torsion strength—the ability to resist twisting
Flexure strength (bending)—the ability to resist tensile and compression forces
Fatigue strength—the ability to resist forces from different directions and/or magnitudes
Impact strength—the ability to resist a rapidly applied load
Ductility—the ability to be formed without breaking
Hardness—resistance to penetration or scratching

Chemical Properties

Oxidation—corrosion caused by a reaction between the material and air, causing rust
Electrochemical corrosion—corrosion caused by electric currents set up in a material in a liquid or moisture as in a battery
Water absorption—the ability to absorb water causing an increased volume and weight

Thermal Properties

Heat resistant—the ability to remain stable with temperature changes
Thermal conductivity—the ability to transfer heat evenly along the length, width, and thickness
Thermal expansion—the rate of size change per unit with the application of heat

Electrical Magnetic Properties

Electrical conductivity—the ability to conduct electricity
Magnetic properties—the ability to be magnetized by external forces

Optical Properties

Opacity—the ability to block light in certain degrees
Color—the appearance depending on the spectrum of light reflected

Acoustical Properties

Material's reaction to sound waves

Material Characteristics Worksheet

Refer to the Material Properties sheet, and list three properties you would or would not want in materials for the following products. Indicate (+) if it is a necessary property, and (-) if is not a good property for the product.

Pistons

1.____

2.____

3.____

Microwave cookware

1.____

2.____

3.____

Construction studs

1.____

2.____

3.____

Firefighters' clothing

1.____

2.____

3.____

Windshields

1.____

2.____

3.____

Superconductors

1.____

2.____

3.____

ENGINEERING MATERIALS AND MATERIAL PROPERTIES

Look at materials we use from the perspective of the user and the manufacturer, and realize the importance of using proper materials in production.

Challenge Statement

Why don't we all wear wooden shoes or sleep on straw mattresses? It seems ridiculous to even ask, but the answers bring up the types of characteristics that engineers and designers must consider for every product they make. Every product has certain uses that require material properties and characteristics for optimum use. New materials are being developed everyday to meet the needs of new products. The challenge is to match material properties with products.

Vocabulary

- Biomaterials
- Electronic materials
- Lubricants
- Biocompatible
- Terms on Material Properties sheet
- Titanium
- Vitallium
- Alloy
- Implant

Equipment/Supplies

- Current events articles
- Materials for lubricant experiment

Introduction

What do glass, wood, Vitallium, and piezoelectrics have in common? They are all materials engineers and designers use to make consumer products. We are familiar with wood, plastics, metals, and ceramics, but they make up only a few of the hundreds of materials available for production.

There are basically five main categories of engineering materials: polymeric, metallic, ceramic, composite, and a broad group of "other" materials. In this activity we will concentrate on composite and "other" materials. Composite materials consist of a group of newly developed materials that are a combination of more traditional materials. This combination allows for the advantage of physical properties from different categories. "Other" materials consist of biomaterials, electronic materials, and lubricants.

The uses and requirements of the product determine the material needed. According to *The Technology Teacher* (April 1991), the ideal material would have the following characteristics:

1. Endless source of supply
2. Cheap to refine and produce
3. Energy-efficient
4. Strong, stiff, and dimensionally stable at all temperatures
5. Lightweight
6. Corrosion resistant
7. No harmful effects on the environment or people
8. Biodegradable
9. Numerous secondary uses

Engineers, scientists, and technologists are continually working to develop new materials that will meet as many of these criteria as possible. Obviously there are no ideal materials at this time, but with advancements in technology, nothing seems impossible.

Meeting all the demands of new product ideas has encouraged engineers to develop new materials called **composite materials**. Plastic impregnated with fiberglass, graphite epoxy, and metal/plastic fittings are examples of composite materials. Combining the advantages of various materials encourages experimentation with new materials.

Often manufacturers hesitate to use new materials, in spite of their positive qualities, because of costs and lack of experience with the material. Car manufacturers are experimenting with a graphite epoxy composite that has a strength-to-weight ratio three to five times greater than steel. The advantage of the material is obvious. The car would be stronger and lighter, thereby getting better gas mileage. Unfortunately, the material costs fifteen to forty times more than steel. The challenge now is to develop a material with similar characteristics that would be inexpensive to produce. Once a reasonable material is found, prototypes must be made and tested to determine the actual results of the product.

"Other" materials make up a broad range of new materials being developed to meet the needs of new technology. *Biomaterials* lead the list with materials used in animals and humans to cure or correct defects due to illness, genetic disorders, or accidents. These materials must be compatible with the living system as implants for maintenance or manipulation.

Vitallium is an alloy of cobalt, chromium, and molybdenum used as an implant to replace arthritic or damaged hips and knees. Approximately 150,000 hip and 160,000 knee replacements are done annually at a cost of $25,000 to $30,000 each. The actual hip joint costs between $800 and $3,000 depending on the parts involved. New knees cost from $2,300 to $2,500 each. The Vitallium is formed into the shape of the end of the damaged bone. The alloy combines with a *biocompatible* plastic which is molded into the shape of cartilage and joined to another piece of Vitallium. The plastic serves as a self-lubricating bearing. After the bone ends have been sawed off, holes are drilled in each end. A two-polymer adhesive is inserted into the holes, and the new joints are fastened. The joint area is stitched. Thousands of people undergo the expense, pain, and inconvenience of the operation to restore their ability to walk.

Titanium is an extremely biocompatible material that is used in a number of different capacities. Scientist do not understand why the body does not reject titanium, but they continue to take advantage of its unusual properties to benefit medical science. It is used as implants in jawbones to screw in prosthetic teeth. Titanium is used as a case for pacemakers, which transmit electric impulses to the heart to keep it from beating too slowly. The pacemaker uses a lithium-iodine battery with leads that attach to the chambers of the heart.

Synthetic lenses are being used in eye surgeries. Cochlear devices are implanted to restore hearing. Heart valves are being replaced. Medical technologists are developing synthetic livers and kidneys. Biomaterials make these improvements possible to restore proper function to many people.

Electronic materials are responsible for the current technological explosion. Liquid crystals, semiconductors, piezoelectrics, superconductors, optoelectronic devices, and magnetic materials have change the direction of communication, biotechnology, transportation, and production. Space exploration and development have encouraged progress in electronic innovations. Society has benefited from the results from something as simple as Velcro to satellite communication to manufacturing space stations. We can look around and see the benefits electronics materials have provided.

The last, but not least, of the "other" materials are *lubricants*. It may seem strange to rate them as a group to themselves, but they are extremely important to industry and society for the smooth working of power devices and materials processing. Without lubricants, cars would not run, elevators would stop, cakes would stick, cutting tools would melt, and machines with bearings would stop. Lubricants reduce friction and wear, and conduct heat away from working parts.

Engineers are working with both solids and liquids to meet demands of new high energy machines. Some solid materials used as lubricants are soap, wax, and even some metals and glass. We are more familiar with liquid lubricants like oil and WD-40.

New materials development is an area of opportunity for people with an interest in science and technology. Ideas for communication, transportation, manufacturing, and space exploration will require extraordinary materials to meet the requirements for new products. Individuals or industries who develop innovative materials will be richly rewarded.

Procedure

1. After reading the Introduction, survey the classroom and identify all the materials you see. List them on the board. Count them to compare with other classes. Now list all the materials inside machines that you cannot see, which make the machines work. Do you have piezoelectric materials in your watch or calculator? (Look it up.) Are there lubricants in machines? Are there ceramics in your computers?
2. Read and discuss the Material Properties sheet. Complete the Material Characteristics Worksheet, discuss it, and turn it in.
3. a. Lubricants save machines and help them run smoothly by reducing friction. To demonstrate friction, rub your hands together quickly. The heat you feel was generated by friction. Imagine a machine with metal parts rubbing together hundreds of times a minute. Now rub your hands together with soap or hand lotion. What is the difference? Is there less heat?
   b. Conduct the experiment with different lubricants as your teacher assigns. Record the times for different lubricants. Which was the most effective? Discuss the importance of and uses for lubricants.
4. Read current events articles from technology-oriented magazines about technological innovations. What kinds of materials are being developed? What kinds of materials are needed for space development? What kind of people would enjoy developing new materials? What kind of training do you think they would need?

Evaluation

You will be evaluated on your participation during discussion and the accuracy and neatness of your Material Characteristics Worksheet.

(5-6 DAYS)

HAZARDOUS MATERIALS: FROM CLASSIFICATION TO DISPOSAL

Essential Elements:	75.50(b): 2A, 2C, 2D, 3A, 3B, 4B, 5A, 6A-E, 7A, 7B, 8A, 8B 75.50(f): 1, 2, 4, 6, 10, 14, 17, 18
TAAS Objectives:	Language Arts: RC 1-6; WC 1-4 Mathematics: C 1, 3, 4

Activity Overview

Your students will learn the criteria for determining a hazardous material, identify businesses that use hazardous materials, and design containers for storage, transport, and disposal of the materials.

Challenge Statement

"A ticking time bomb primed to go off." That is what the Surgeon General of the United States called the hazardous disposal problem in the United States in 1980. Years later we are in a much more critical situation with over 24 million tons of nuclear waste alone in underground storage.

The obvious solution is to stop producing hazardous waste. Unfortunately, hazardous wastes are a by-product of our technological society. To give up the by-product, we give up the benefits of the materials of production. We must come up with another answer.

In order to protect the environment, plants, and people, extreme care must be taken to prevent accidental misuse of these products. To protect us, regulations have been established to restrict the use of certain materials. This unit is designed to make students aware of the need for safe transport, storage, and disposal of these materials and to present them with a creative problem-solving situation.

Systems Model

Resources
Students as researchers, information gatherers, and design engineers
Instructor as resource person, monitor, and evaluator
Sketching supplies

Processes
Reading and study of new concepts
Application of ideas and concepts to design
Designing a containment system
Gathering information from local businesses
Reporting information and design ideas
Evaluating containment systems

Applications
Technology skills and knowledge to current social problem
Application of ideas and concepts to design
Assessment to design skills and concepts

Impact
Career choices
Safe containment of hazardous materials
Social responsibility

Interfacing with Other Disciplines

Language Arts:	Students will learn new words and concepts. They will review the phone book and identify businesses that use hazardous materials, then interview an employee over the phone and record the information.
Mathematics:	Students will review information that involves measurement. They will draw a container as a solution to a challenge and represent it in geometric terms.
Science:	Students will learn to classify hazardous materials and hazardous waste. They will understand the impact of unsafe disposal on the environment.
Social Studies:	Students will become aware of the impact of hazardous materials on society and develop an understanding of social responsibility.

Critical Thinking Skills Reinforced

The students will evaluate a problem situation, apply new and old concepts and skills, and design a solution to the problem. They will report their solutions and evaluate the solutions of the class to formulate a plan of storage, transport, and disposal for hazardous waste.

Teaching Tips

1. Have a number of current events articles about all aspects of hazardous waste to enhance the introduction of the topic on the first day. It may be likely that your community is dealing with a waste disposal issue. You students need to be aware that this is an issue that affects each of us.
2. Involve the science and social studies classes as much as possible. There are many issues in this area from which to build an interesting unit. Give the teachers plenty of advance notice (weeks or months) to prepare and time coinciding activities.

Instructional Strategy

You will gather current events materials to enhance the introduction of the activity and make it more real to the students. Help students compile the list of businesses to survey, and monitor the class as they design containment systems. With the class, evaluate the design solutions, and devise a plan for safe storage, transport, and disposal of hazardous waste.

Equipment/Supplies

1. Pencil, paper, and pen
2. One telephone directory for every three students
3. Drafting supplies
4. CADD, if available

Evaluation Key

As with everything they do, grade your students on behavior and cooperation. Grade them on the neatness and quality of their drawings.

Modifications for Handicapped, Disadvantaged, and LEP Students

Some students may need assistance with drawings depending on the standards required.

Support Materials

1. Blumberg, L., and R. Gottleib. *War on Waste: Can America Win Its Battle with Garbage?* Washington, D.C.: Island Press, 1989.
2. Hacker, M., and Barden, R. *Living with Technology.* Worcester, Mass.: Davis Publications, 1988.

3. Macaulay, D. *The Way Things Work*. Boston: Houghton Mifflin, 1988.
4. Markert, L. R. *Contemporary Technology: Innovations, Issues, and Perspectives*. South Holland, Ill.: Goodheart-Willcox, 1989.
5. Pringle, L. *Nuclear Energy: Troubled Past, Uncertain Future*. New York: Macmillan, 1989.
6. Pytlik, E. C., et al. *Technology, Change, and Society*. Worcester, Mass.: Davis Publications, 1986.
7. U.S. Postal Service. *Domestic Mail Manual*, Issue 39, June 16, 1991.
8. *The Technology Teacher*, "Hazardous Waste Disposal," December 1989.

PLACES TO WRITE

Atlantic Richfield Co., Public Relations Dept., P.O. Box 2819, Dallas, TX 75221
Center for Renewable Resources, 1001 Connecticut Ave., N.W., Washington, DC 20036
Modern Talking Picture Service, 1411 Slocum St., Dallas, TX 75203
Shell Film Library, Scheduling Center, 5000 Park St. North, St. Petersburg, FL 33709

Concerns Surrounding Hazardous Wastes

Major concerns about transporting hazardous wastes are:

1. ____
____

2. ____
____

3. ____
____
____

Major concerns about storing hazardous wastes are:

1. ____
____

2. ____
____

3. ____
____
____

Major concerns about disposing of hazardous wastes are:

1. ____
____

2. ____
____

3. ____
____
____

HAZARDOUS MATERIALS: FROM CLASSIFICATION TO DISPOSAL

Learn the criteria for determining a hazardous material, identify businesses that use hazardous materials, and design containers for storage, transport, and disposal of the materials.

Challenge Statement

"A ticking time bomb primed to go off." That is what the Surgeon General of the United States called the hazardous disposal problem in the United States in 1980. Years later we are in a much more critical situation with over 24 million tons of nuclear waste alone in underground storage.

The obvious solution is to stop producing hazardous waste. Unfortunately, hazardous wastes are a by-product of our technological society. To give up the by-product, we give up the benefits of the materials of production. We must come up with another answer.

Objectives

- To understand the classifications of hazardous materials and hazardous wastes
- To understand the problems related to storage, transport, and disposal of hazardous materials and wastes
- To design containers for the storage, transport, and disposal of hazardous materials and wastes
- To identify local businesses that use hazardous materials

Vocabulary/Concepts Reinforced

- Hazardous waste
- Municipality
- Landfill
- Ignitability
- Corrosivity
- Sanitation practices
- Regulatory practices
- Regulatory policy
- Biotechnology
- Reactivity
- EPA
- Deep well injection
- Incineration
- Genetic engineering
- EP toxicity

Equipment/Supplies

- Pencil, paper, and pen
- One telephone directory for every three students
- Drafting supplies

Introduction

For the past fifty years, new technology has provided us with numerous advantages and benefits. One benefit has been the development of new materials and processes to get a job done. Examples are powerful explosives for clearing land and for military defense, pesticides for protecting crops and rangeland, medicine for treating terminal diseases, and preservatives for treating wood. The evolution of nuclear power is an important technology to meet our energy needs. All of these advances require hazardous materials and produce hazardous waste. These materials are only beneficial within certain guidelines; outside of that they become deadly.

Hazardous materials are used in many different applications, including industry, medicine, scientific research, utilities, and the military. These materials include chemical matter, flammable liquids, flammable solids, corrosives, compressed gases, poisons, and radioactive materials. Like all products, these materials must be transported and stored for use. In many cases, hazardous wastes that must be disposed of safely are the result.

A number of criteria have been set by the Resource Conservation and Recovery Act (1976) to determine hazardous waste. (1) *Ignitability*—Is the material capable of exploding or causing a fire during normal handling? (2) *Corrosivity*—Will the material deteriorate standard containers or produce toxic components from storage materials? (3) *Reactivity*—Does the material react violently with water or generate toxic gases? (4) *EP Toxic*—Is the material poisonous?

According to Barbara Blum of the Environmental Protection Agency (EPA), less than 10 percent of all hazardous waste has been disposed of properly. The Comprehensive Environmental Response, Compensation and Liability Act of 1980 was created to clean up past, unsafe hazardous waste deposits. This Superfund, as it is called, provides $1.6 billion to do the job.

With the growing need for safe disposal, the hazardous waste disposal industry is thriving. In spite of the risk, many companies are willing to take on the job, because the need is great, and the profit can be high. Five methods of disposal are being developed. (1) *Landfilling*—This involves lining a specially designed landfill with clay and covering it with a material that is resistant to the waste placed there. (2) *Deep well injection*—Hazardous waste is diluted and injected thousands of feet into the earth's surface into porous geological zones. (3) *Incineration*—Hazardous wastes are burned at temperatures between 1,500°F and 1,600°F. (4) *Biotechnology*—Live bacteria break down hazardous wastes. (5) *Genetic engineering*—New organisms are created by altering the genetic structure of existing microorganisms. These organism are designed to "eat" specific wastes.

Another option that needs to be considered, on a per material basis, is the reuse (recycle) of by-products from hazardous materials. Can hazardous waste be used for another purpose which would break down the material even more? For example, plutonium, which is a by-product of nuclear energy production, is estimated to lose only one-half its radioactivity in 24,000 years. Can plutonium be used for another purpose?

Procedure

1. Read, discuss, and study the Introduction and Vocabulary. Brainstorm concerns centered around storage, transport, and disposal of hazardous waste. Complete the "Concerns" sheet.
2. Look in the Yellow Pages of the phone book. Identify five businesses that you think use hazardous materials or produce hazardous wastes. Compose a class list of the businesses, with phone numbers. Are there any materials classified as hazardous in your technology lab? What are they? Why are they considered hazardous?
3. While the class is working on the following activity, some students will call the businesses on the list and ask the following questions, then complete the design assignment. Make the calls one or two students at a time. (Begin the call by introducing yourself and explaining your assignment.) Write down the information they give you. Questions to ask:
   a. Do you use any hazardous materials in your business?
   b. What agency sets guidelines for use of the material?
   c. Do you have any laws that inform your employees about the hazardous materials? What are they?

   d. Are there penalties for misuse? If yes, what are they?
   e. Do you have guidelines for disposing of the hazardous wastes?
   f. Are the disposal guidelines easy to meet or are they inconvenient?

   Thank them for their time, and ask if there is any information they could send the class. Be sure to have the school address available, in case they do.

4. You will all complete the following activity while the calls are being made. Design and sketch a container for storage, transport, *or* disposal of a hazardous material. If you have a CADD available, use it. You may need to design robots or computers into the system to make it safe for humans and cut down on human contact.. Answer the following questions on the back of your drawing.
   a. Is your container used for storage, transport, or disposal?
   b. What criteria make your material hazardous? (Study the criteria in the Introduction.)
   c. Could your container be used for more than one function?
   d. Are robots used to handle the material in order to protect humans? If yes, draw them into the system.
   e. Is a computer used to monitor the material? What does it monitor?
   f. What characteristics would the material of the container need to hold the hazardous material? Does such a material exist?
5. The students who made the phone calls will report on information from the businesses they contacted. Was the information from the businesses similar? What agencies set guidelines for use of hazardous materials? Do you think the businesses follow the guidelines for disposal? Why? What could be done to ensure that the materials are being disposed of properly?
6. Display your sketch, and explain the use of your container. Watch as the other students display their work.
7. What were the best qualities of all the containment systems? What do you think is the best disposal system? What guidelines should be set for the safe disposal of hazardous waste? Who should enforce the guidelines? What should be the penalties for failure to comply?

Evaluation

As with everything you do, you will be evaluated on your behavior and cooperation. You will also be graded on the neatness and quality of your drawing.

BRIDGE CONSTRUCTION

Essential Elements: 75.50(b): 2C, 4A, 4B, 5A, 5B, 6A, 6B, 8A, 8B
75.50(f): 1, 10, 15
TAAS Objectives: Language Arts: RC 1-5
Mathematics: C 1-5; O 1, 4; PS 1-4

Activity Overview

Your students will work with a partner to learn about structural loads and forces, design a bridge, and conduct a load test until the bridge breaks. They will be able to determine which materials and structures have advantages of strength by comparing their experiment with others in the class.

Challenge Statement

Engineers must make roads, highways, and bridges safe for all types of traffic. With the load on bridges varying with the load of cars and trucks, and the force of the wind and weather, a number of important factors must be considered. The maximum strength of a structure can only be determined when the structure breaks. It is necessary for engineers to design structures to support weights and stresses well above the maximum load capacity.

Your students will have the opportunity to learn about different types of bridge structures and loads, and design a bridge that will withstand a large amount of weight. Their goal is to design and construct a bridge that will support the most weight possible.

Systems Model

Resources
Instructor as materials organizer, resource person, and class monitor
Students as students, engineers, experimenters, and evaluators
Supplies and tools necessary to build and test the bridges

Processes
Lecture and discussion on structural loads and bridge types
Design and drawing bridge prototypes
Testing prototypes for load and determining efficiency ratings
Evaluating the strength of varying structures

Applications
Knowledge base to bridge designs
Creative problem solving to bridge designs
Evaluation process to conclusions about structures

Impact
Careers in engineering
Social responsibility relating to safety

Interfacing with Other Disciplines

Mathematics:	The students will work with an architect's and engineer's scales to draw the design of their bridge. They will use math skills to find the efficiency ratio of each structure.
Science:	The science students will determining physical characteristics of structures and materials in testing their bridges. They will study and utilize the concepts of load, load-bearing structure, force, resistance, and other appropriate laws of physics, as they work with the various structural components of building. Through experimentation, they will develop an understanding of gravity and its effect on structures.
Social Studies:	Students will be aware that there are laws governing building codes and restrictions.

Critical Thinking Skills Reinforced

Through problem solving and experimentation, students will be able to make application to building structures about the general law of gravity. They will evaluate and analyze each bridge to gather insight into structural design and the physical properties of materials.

Teaching Tips

1. To introduce the unit, read through the Introduction on the student activity sheet. and make transparencies of the four bride designs to show the distribution of load on the structures.
2. Allow each student to choose a partner for the lab activity. Give them the standards that you expect for their drawings. The bridge will span 12" to 18". You may want them to draw the bridge full scale, if enough paper is available.
3. Determine the amount of materials that they will be allowed to use, and divide the materials in advance. The students must keep their materials together to use during the following lab days.
4. Tie a rope or strap through the handle of the bucket. Place the strap over the top of the bridge, and pour sand very slowly into the bucket. When the bridge breaks, weigh the sand to determine the load and the bridge to determine the efficiency ratio.
5. To evaluate each bridge, lay out the drawings of the prototype, the broken bridge, and the efficiency rating. Have the students compare the efficiency ratings with the bridge structure to make observations about construction and structural strength.

Instructional Strategy

- Lecture to present the topic to students.
- Use group discussion in the presentation of the topic.
- The students will use teamwork and peer teaching to develop and build a bridge according to standards you determine.
- Use individualized instruction where appropriate.

Evaluation Key

1. Evaluate your students on their participation and behavior during the activity.
2. Grade them on the neatness and quality of their drawings.
3. Evaluate them on how well their bridge was built in accordance with their drawings.
4. You may want to give extra credit to the partners with the highest efficiency rating.

Test Answer Key

1. D
2. A
3. B
4. D
5. C
6. A
7. D
8. D
9. B
10. D

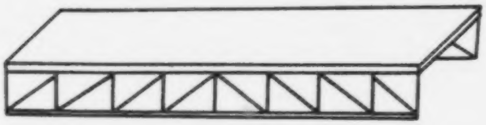
Support Materials

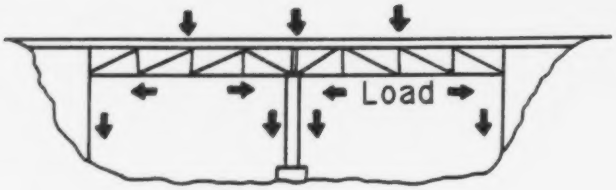
1. Horton, A., et al. *Exploring Construction Systems*. Worcester, Mass.: Davis Publications, 1991.
2. Ritz, J., et al. *Exploring Production Systems*. Worcester, Mass.: Davis Publications, 1990.
3. Scharff, R. *Workshop Math*. New York: Sterling Publishing Co., 1989.

Modifications for Handicapped, Disadvantaged, and LEP Students

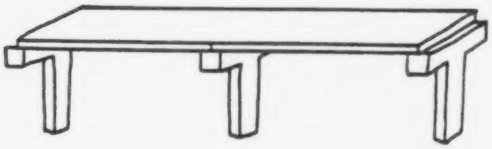
Additional time may need to be given for the bridge construction. Working with a partner will be sufficient help for most students. All students must work carefully around tools and equipment.

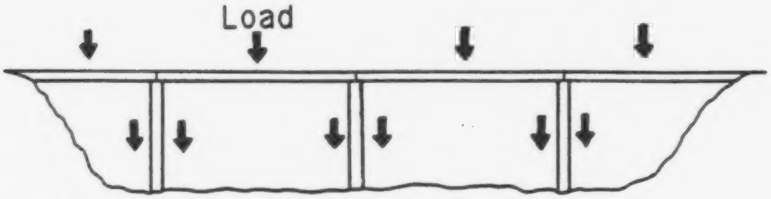
Trussed Bridge



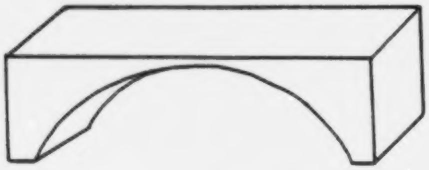


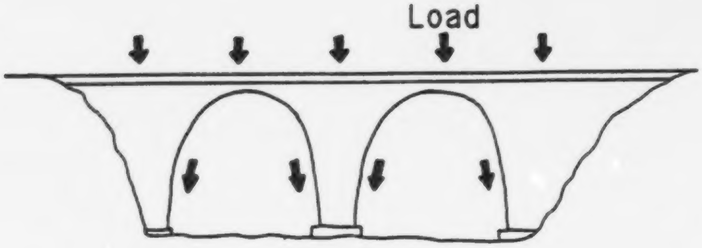
Beam Bridge



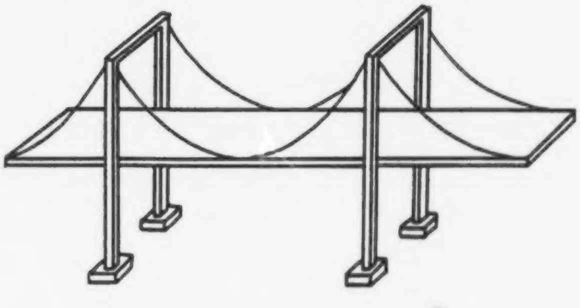


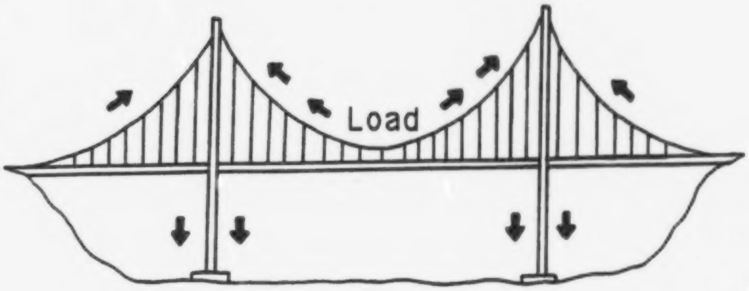
Arch Bridge





Suspension Bridge





Name________________________________

Structural Evaluation Test

Directions: Read each statement carefully. Select the word or phrase that correctly answers or completes the statement, and write the appropriate letter in the blank. Each correct answer earns 10 points.

________ 1. A force or weight causing the structure to resist the downward forces of gravity is ____________.

A. beam
B. truss
C. foundation
D. structural load

________ 2. The weight load originating from the structural components, mechanical devices, railings, etc., that are a permanent part of the structure is called the _____________.

A. dead load
B. live load
C. structural load
D. lateral load

________ 3. The weight load originating from the nonpermanent fixtures of a structure including people, cars, trucks, ice, snow, rain, etc., is called the _____________.

A. dead load
B. live load
C. structural load
D. lateral load

________ 4. Wind pressure against the side of a bridge causes a structural load commonly called a _______________.

A. dead load
B. live load
C. structural load
D. lateral load

________ 5. The force of nature that causes all objects to be pulled toward the ground is ____________.

A. wind
B. magnetism
C. gravity
D. weight

________ 6. The electrical wiring on a bridge contributes to the _____________ weight of the structure.

A. dead load
B. live load
C. structural load
D. lateral load

_______ 7. Wind loads are caused by the pressure of wind against the side of a structure. Wind loads are generally considered to be part of the ________ load classification.
A. dead
B. live
C. structural load
D. lateral load

_______ 8. Earthquake movement is a type of ___________.
A. dead load
B. live load
C. structural load
D. lateral load

_______ 9. A structure is only as strong as its ______________.
A. weight
B. weakest link
C. foundation
D. dead load

_______ 10. One of the following is *not* a characteristic affected by structural loads.
A. strength
B. stability
C. rigidity
D. elasticity

BRIDGE CONSTRUCTION

Work in a group to learn about structural loads and forces, design and build a bridge, and conduct a load test until the bridge breaks; determine which materials and structures have strength advantages.

Challenge Statement

Engineers must make roads, highways, and bridges safe for all types of traffic. With the load on bridges varying with the load of cars and trucks, and the force of the wind and weather, a number of important factors must be considered. The maximum strength of a structure can only be determined when the structure breaks. It is necessary for engineers to design structures to support weights and stresses well above the maximum load capacity.

You and your partner will have the opportunity to learn about different types of bridge structures and design a bridge that will withstand a large amount of weight. Your goal is to design and construct a bridge that will support the most weight possible.

Objectives

- To describe the basic structural effects of stability, strength, and rigidity
- To understand structural loads including live, dead, and lateral loads
- To understand structural forces
- To design and construct a bridge taking into account structural effects and forces, and the properties of materials

Vocabulary/Concepts Reinforced

- *Building codes*—laws and regulations used by governing agencies to establish minimum standards for a wide range of design and construction practices. Building codes are established at all levels of government from national to local standards.
- *Concentrated load*—a structural load that is concentrated on one small area of a structure rather than being spread over a larger area.
- *Dead load*—a structural load, usually stationary, created by the constant weight of the structure on itself.
- *Density*—in construction terms, density refers to a material's weight per cubic foot.
- *Efficiency rating*—a measure of structural efficiency created by identifying the ratio of the live load to the dead load of a structure; E.R. = live load/dead load
- *Factor of safety*—because no structural member of a building is designed to carry its full load capacity, a margin of safety well below its ultimate load capacity is designed into the structure; also called *safety factor*.
- *Lateral load*—a lateral force or load against a structure usually created by wind pressure.
- *Live load*—a structural load, usually variable, that is created by the weight of objects that are not a permanent part of the structure.
- *Load*—the various weights or forces applied to a structure.
- *Uniform load*—a structural load that is spread evenly over a large area.
- *Volume*—a measure used to calculate the cubic capacity of a material. Volumes of construction material are usually measured in cubic feet or cubic yards. The formula for calculating volume is length × width × depth.

Equipment/Supplies

- Assorted hand tools
- Jig or scroll saw
- Large bucket with a handle
- Sand
- Wood strips
- Cardboard
- Wood glue and hot glue
- One sheet of paper or newsprint

Introduction

Structural Loads

To understand the concept of a load on a structure, we must first determine what a load is. Basically, a *structural load* is any force or weight causing the structure to resist the downward forces of gravity. There are three basic types or sources of loads that cause a structure to work. The first source is the weight of the structure itself, referred to as the *dead load.* Dead loads consist of the weight of all building materials and permanent fixtures within the structure. The second source includes all nonpermanent elements such as people, ice, cars, snow, and rain water. These loads or forces are called *live loads*. The third type of structural load is *lateral loads*. A lateral load is created by the added stress against a structure caused by wind pressure. Any bridge that is constructed must be designed and built with these three structural loads in mind. Failure to properly address any of these elements can cause catastrophic failure of the structure.

Wind Loads

Wind loads are based on historical data gathered by meteorologists for wind conditions all across the country. They continually update this information and record the highest wind gusts over different periods including 30-, 50-, and 100-year time spans. This data is recorded on maps that plot where these winds might occur. For practical application this information is charted for all types of structures.

Structural engineers have established minimum wind loads for these various areas. They calculate loads based on withstanding the highest wind that might occur during a 50-year time span. This means that the bridge and its occupants will not be damaged by 50-year winds and will suffer only moderate damage from 100-year winds. Wind load calculations are very important considerations for nearly all structures that rise 30 feet or more above the ground.

Earthquakes

Although not a critical problem in all areas of the country, some regions have the added problem of designing structural loads to withstand the dynamic forces of earthquakes. While wind loads affect the upper structural areas, earthquake loads affect the foundation. In an earthquake, the force is a lateral pressure exerted horizontally against the side of the foundation.

Strength, Stability, and Rigidity

In order to resist these various loads, engineers must design into their structures three important characteristics—*strength, stability,* and *rigidity.*

Strength is tied directly to the materials used, their location within the structure, and the manner in which they are secured to each other. A structure is only as strong as its weakest link. Structural failures occur at the point of least resistance. The gravitational pull on a structure is constant and will seek out the point at which the least resistance occurs. The weak link may be the material selected for a particular use. If the material is not suitable for a specific use, it should not be used. Building codes restrict the use of particular materials to applications where they are safe.

Stability is also a factor affecting structural integrity. Stability is the property of the bridge that causes it, when disturbed from a condition of equilibrium, to develop forces that restore the original condition.

Rigidity is the third element affecting structural integrity. Rigidity takes into account the types of structural elements used, how they are assembled, and what materials are used to construct them. Rigidity is also greatly affected by proper connection of the various structural elements.

No structural member of a bridge is ever designed to carry a load which develops its maximum strength capacity under normal service conditions. The maximum strength capacity is reached when the material or the structural component fails. Engineers and architects design into their work a margin of safety. This is commonly called the factor of safety or safety factor. Basically, it provides for allowable working stresses well below the maximum strength capacity of either a material or a structural component.

Engineers, architects, and construction workers are required to follow strict guidelines for proper use of both materials and construction practices. These guidelines are contained in both building codes and industry standards. A practical knowledge of the structural loads and how they affect structures is very important to the safety and well-being of the community in which a structure is built.

Procedure

1. Listen carefully and take notes on the loads and forces that effect bridges and the different bridge styles. You will need this information to construct your bridge.
2. Discuss your notes with your partner, and determine the type of bridge you and your partner will build.
3. Pay close attention to the standards your teacher sets for your bridge construction, then draw your bridge to scale using standard drawing practices.
4. Build your bridge using only the materials your teacher has given you. You do not want to be disqualified.
5. Test your bridge for the maximum load by suspending it between two tables, putting the strap over the bridge and hanging the bucket. *Slowly* pour sand into the bucket until the bridge, breaks completely. Weigh the bucket and sand after it breaks to determine the maximum load your bridge could hold.
6. Determine the efficiency rating for your bridge. (E.R. = live load/dead load). The team with the highest efficiency rating had the strongest bridge.

Evaluation

1. You will be evaluated on your participation and behavior during the activity.
2. You will receive a grade on the neatness and quality of your drawings.
3. You will also be evaluated on how well your bridge was built in accordance with your drawings.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR RESOURCE SHEET 28
(7-10 DAYS)

ROCKET PRODUCTION

Essential Elements:	75.50(b): 1A, 2C, 2D, 4A, 4B, 5A, 5B, 6A, 6B, 6D, 6E, 8A, 8B 75.50(f): All
TAAS Objectives:	Language Arts: RC 1-4 Mathematics: C 1-4; PS 1-4

Activity Overview

Using materials supplied, the students (in groups) will manufacture an operational model rocket.

Challenge Statement

Understand that processes used in the manufacturing and production of a rocket body, fins, nose cone, and launch lug are applicable to any manufactured products.

Systems Model

Resources
Students as engineers
Teacher as resource person and monitor

Processes
Designing rockets
Forming, separating, assembling, and finishing rocket parts
Launching rockets and tracking flight

Applications
Math skills to technology
Science knowledge to technology

Impact
Transportation systems
Space technology

Interfacing with Other Disciplines

Language Arts:	Students will read and study information in handouts and follow written directions in making a rocket.
Mathematics:	Students will use measurement to design and construct a rocket.
Science:	Students will launch and track rocket's flight and experiment with aerodynamics.

Critical Thinking Skills Reinforced

Problem solving, sequencing, analysis

Teaching Tips

1. Read the student information sheet
2. Before assigning the activity to the students, build a rocket yourself.
3. Demonstrate the entire rocket construction to the class.
4. Develop a CNC lathe nose cone program for the students to use.

5. Use testing procedure to ensure stability of each rocket.
6. Demonstrate launch safety procedures to class.

Instructional Strategy

- Motivate students to learn technical and scientific principles through a hands-on activity.
- Organize materials in advance of student participation.
- Organize students into functional groups to complete the project. Each group will be provided an opportunity for success through this activity.

Equipment/Supplies

1. Body tube: dowel rod (3/4" dia)
2. Tag board (24" × 36")
3. White glue
4. Masking tape
5. Floor wax (paste)
6. Small paintbrush
7. 220-grit abrasive paper
8. Sanding sealer
9. Scissors/paper cutter
10. X-acto knife/razor blade
11. Fins: balsa wood sheet (1/8" × 1" × 12")
12. Pattern sheet
13. Nose cone: balsa wood block (1" × 1" × 2")
14. Launch lug: dowel rod (1/8" × 6")
15. Tag board (12" × 12")

Evaluation Key

1. Each group grades their portion of the product. A total of 400 points is available to the group. Within the group, each student assigns a number of points to him/herself and the other group members (not to exceed 100 points per student). The ones who did the majority of work should receive the higher points.
2. Product grading is based on the quality of the finished part. For example:
    a. The launch lug and body tube should be free of wrinkles, and each joint should be tight and the surface smooth.
    b. The nose cone should be to the exact dimensions, the surface smooth, and it should fit snugly in the body tube.
    c. The fins should be smooth, edges square, and match the pattern.
3. For the individual rockets, the fins should be square to the body, the finish on the rocket should be uniform and the rocket should stand straight.
4. For the flight grades, the rocket should not "spin," at the apex of the flight the rocket should "arc over," and the rocket should survive the landing with little or no damage.

Manufacturing Processes Test

Matching	*Multiple Choice*	*Identification*
1. C	1. C	1. I
2. B	2. C	2. R
3. E	3. C	3. R
4. A	4. B	4. I
5. D	5. B	5. R
6. F		

Support Materials

1. The following software and publications are available from Estes Industries, Penrose, CO 81240:
   - Physics of Model Rocketry Flight: Aerodynamics of Model Rockets
   - In Search of Space: Introduction to Model Rocketry
   - AstroCad
   - AeroTrek
   - *Industrial Arts Teachers Manual for Model Rocketry Projects in Model Rocketry Camp Leader's*
   - *Model Rocketry Manual*
   - *Model Rocketry—The Space Age Teaching Aid*
   - *Alpha Book of Model Rocketry*
   - *Model Rocketry Study Guide*
   - *The Classic Collection*
   - *Aerodynamic Drag of Model Rockets*
   - *Model Rocketry Technical Manual*
2. Daiber, Robert A., and Erekson, Thomas L. *Manufacturing Technology: Today and Tomorrow.* Mission Hills, Calif.: Glencoe/McGraw-Hill, 1991.
3. O'Keefe, Cynthia A., et al. *Applied General Education Through Technology Education.* Austin: EIMC, The University of Texas at Austin, 1992.
4. Rossie, John P. *Handbook for Aerospace Education.*. Littleton, Colo.: Aerospace Educational Development Program, 1989.
5. Rossie, John P, et al. *Handbook Two for Aerospace Education: A Guide to Projects and Applications.* Littleton, Colo.: Aerospace Educational Development Program, 1991.
6. *Technology Education: Introduction to Technology.* Albany, N.Y: The State University of New York, The State Education Department, Division of Occupational Education Programs, 1987.

Modifications for Handicapped, Disadvantaged, and LEP Students

1. Place each special needs student within a group so that other group members can help these students.
2. Modify grading as needed.
3. Testing material(s) may need to be delivered orally.
4. Supervise closely students using dangerous equipment (lathe, lathe and chisels, X-acto knives/razor blades).
5. Use peer tutoring throughout the unit.

Name ______________________________

Manufacturing Processes Test

Directions: Write the letter of the term in the blank next to the statement it defines.

Matching

A. Conditioning
B. Forming
C. Process
D. Assembling
E. Separating
F. Finishing

_______ 1. A set of actions or changes in a specific order.
_______ 2. Process of changing the shape of an object, but not its volume.
_______ 3. Process of shaping a product by removing unwanted material by cutting it away.
_______ 4. Process of changing the mechanical properties of material.
_______ 5. Process of temporarily or permanently binding materials together.
_______ 6. Process of coating a product to protect it and/or to change its appearance.

Multiple Choice

Directions: Choose the letter that best answers or defines the statement, and place the letter in the blank by the number.

_______ 1. The process of pouring or forcing a liquid into a mold and allowing it to solidify and form a ceramic product.

A. forming
C. casting
B. molding
D. process

_______ 2. The process of pouring or forcing a liquid into a mold and allowing it to solidify and form a metal or plastic product.

A. casting
C. molding
B. forming
D. finishing

_______ 3. The production method used when a large number of parts are needed

A. custom manufacturing
C. continuous manufacturing
B. intermittent manufacturing
D. prototyping

_______ 4. The production method used when demand for a product is low.

A. custom manufacturing
C. continuous manufacturing
B. intermittent manufacturing
D. line production

________ 5. The production method used when a few or only one product is needed.
- A. prototyping
- B. intermittent manufacturing
- C. custom manufacturing
- D. continuous manufacturing

Identification

Directions: Place an "R" in the blank if the material is considered a raw material. Place an "I" in the blank if the material is an industrial standard stock.

_____1. Paper (on a roll)
_____2. Trees
_____3. Bauxite (aluminum ore)
_____4. Copper bars
_____5. Latex

ROCKET PRODUCTION

Manufacture model rocket parts to produce an operational model rocket, using materials supplied and working in a group.

Challenge Statement

Understand that the processes used in the manufacturing and production of rocket body, fins, nosecone, and launch lug are applicable to any manufactured products.

Objectives

- To gain a basic knowledge of the manufacturing processes
- To assemble and finish an operational rocket kit
- To produce the parts of a rocket kit
- To gain a knowledge of quality control
- To learn fundamental use of a variety of tools
- To learn a variety of methods of applying finishing materials

Vocabulary/Concepts Reinforced

- *Assembling*—process of temporarily or permanently binding materials together.
- *Casting*—process where a liquid is poured or forced into a mold and is allowed to solidify (ceramics).
- *Conditioning*—process of changing the mechanical properties of a material.
- *Continuous manufacturing*—production method used when a large number of parts are needed.
- *Custom manufacturing*—production method used when only a few products or even only one product is made.
- *Finishing*—process of coating a product to protect it and to change its appearance.
- *Forming*—process of changing the shape of an object but not its volume.
- *Industrial standard stock*—a refined raw material in a usable form (lumber, steel, chemicals, etc.).
- *Intermittent manufacturing*—production method used when the demand for a product is low.
- *Manufacturing*—the process of changing raw materials into finished products.
- *Molding*—process where a liquid is poured or forced into a mold and is allowed to solidify (plastics and metals).
- *Ore*—earth and rock from which metal can be extracted.
- *Process*—a set of actions or changes in a specific order.
- *Raw materials*—materials as found in nature (trees, ores, etc.).
- *Separating*—process of shaping a product by removing unwanted material by cutting it away.

Equipment/Supplies

- Body tube: dowel rod (3/4" diameter)
- Tag board (24" x 36")
- White glue
- Masking tape
- Floor wax (paste)
- Small paintbrush
- 220-grit abrasive paper
- Sanding sealer
- Scissors/paper cutter
- X-acto knife/razor blade
- Fins: balsa wood sheet (1/8" x 1" x 12")

- Pattern sheet
- Nose cone: balsa wood block (1" x 1" x 2")
- Launch lug: dowel rod (1/8" x 6")
- Tag board (12" x 12")

Introduction
This activity will introduce you to manufacturing processes. *Manufacturing*, as defined, is the process of changing raw materials into a finished product. Most items are manufactured, such as pencil, paper, desks, tables, chairs, clothing, shoes, and other things around you. Raw materials are those items found in nature, or their natural form. Raw materials include trees, ores, or natural compounds (salt, water), and even plants.

Raw materials are not always in a usable form. Trees must be cut into logs and then into lumber, and ores must be smelted into metals to serve a useful need for people. Other raw materials can be used as they are found in nature. Gravel and sand may be used to construct roadways, and fruit may be picked and eaten. When raw materials are turned into usable forms, these materials are then called *industrial standard stocks*. Logs from trees are cut into lumber (construction lumber and cabinet grade), ores are smelted into metal (aluminum, copper, iron, silver), and cotton is processed into cloth.

Chemicals (oxygen, hydrogen, and argon) are also industrial standard stocks. In order for industrial standard stocks to become products, they must be further processed. This is where manufacturing is important.

As was stated, manufacturing is the process of changing raw materials into finished products. To do this, people use tools and processes to make this conversion. Tools, in this situation, are used to perform the processes. Processes include casting, molding, forming, separating, conditioning, assembling, and finishing, and they are used every day around the world in manufacturing plants.

Casting and **molding** are two very similar processes, but the materials used are very different. Casting is a term normally used when ceramic materials are processed. Molding involves metals or plastics. In the processes of casting and molding, industrial standard stocks are made liquid and then poured or forced into a mold. The material then cools and solidifies and is removed from the mold. This is much like when water is poured into an ice tray, frozen to form ice, and removed as a cube.

Forming processes only change the shape of a material. Rolling paper into a tube, as you are going to do in this activity, is a forming process called *rolling*. Other types of forming are *shaping* dies used in making silverware, *blow molding* used in making glass bottles, and *extrusions* used in making aluminum window frames.

Separating processes are divided into two categories, machining and shearing. *Machining* is a process of shaping a material by removing unwanted portions of it. The unwanted portion in the form of chips or waste can sometimes be recycled. An example of this process is sawing a board, where the unwanted portion becomes waste and sawdust. *Shearing* is a process of fracturing a material between two edges. In this process, there are no chips involved as there is with sawing. An example of shearing is a pair of scissors cutting a piece of paper. The paper is only divided into two pieces.

Conditioning processes are those that add specific qualities to materials. These qualities are called mechanical properties, which means that they may look the same but they act differently in a given situation. For example, a knife blade is made of steel, the blade is hard, but it will not hold a sharp edge unless it is heat-treated. Heat-treating the blade will make it harder and last longer.

Assembling processes are used to bind materials together. These processes range from mechanical fasteners (nails, screws, nuts, and bolts), adhesives (glues), gas and arc welding, to wood and metal joints. These processes may be temporary or permanent to hold a product together.

Finishing processes are applied to products to protect them from the elements and/or to improve its appearance. There are many different types of finishes, but they all have the same purposes. Finishes my be sprayed, brushed, or rolled on the product, or the product may be dipped into the finish. Examples are paint on a car, chrome on the bumper of a car, and gold plate on jewelry.

The aforementioned processes are all or partly involved in the manufacturing of a product. There are several ways a product may be built or manufactured. Types of manufacturing include continuous manufacturing, intermittent manufacturing, and custom manufacturing. These three types of manufacturing can involve the same tools, materials, and processes. The only differences may be the number of products that are produced, the time it takes to produce them, and the overall quality of the products.

Continuous manufacturing is where the product changes very little. The things that will change on the product are small and insignificant: color, hardware, and material. Line production is a continuous manufacturing of one type of product. An automobile's style and shape changes, but the workers have to change the processes they use very little to perform their jobs. The workers become very skilled at the job they are to perform, which ensures quality and efficiency. Production lines are also usually mechanized.

Intermittent manufacturing is used when markets cannot support continuous manufacturing. When demand for a product is low, the product is produced in smaller quantities. Then the factory is retooled to produce a different product. An example of this is a machine shop that machines parts for several other larger manufacturers. The workers in these shops must be very skilled and versatile to perform their jobs.

Custom manufacturing is the oldest form of manufacturing. Custom manufacturing involves the production of few or even only one product. The research and development departments in larger companies are examples of custom manufacturing. They may build a product and test it to see it is a good product for the company to produce. The workers involved in production must be skilled in all the processes required to produce the product to maintain good quality. This is also the slowest form of production because only one person may work on the product from start to finish.

Procedure

Materials Needed for Body Tube

Dowel rod (3/4" × 12"), tag board (24" × 36"), masking tape, floor wax, glue, small paintbrush, 220-grit abrasive paper

1. Apply a coat of wax to the dowel rod.
2. Buff the wax-coated dowel rod to a smooth finish.
3. Cut the tag board sheet into 1-1/8" x 24" strips (edges must be parallel). You need two strips for each body tube.
4. You are going to form a spiral around the dowel rod using the tag board. To do this, tape one end of the tag board to the end of the dowel rod at an angle. Wrap the tag board around the dowel rod, being careful that each edge of the tag board butts together. Leave no gaps, and do not overlap the edges of the tag board. See figure 1.
5. After wrapping the strip of tag board the length of the dowel rod, tape the other end of the tag board to the dowel rod.
6. Using a small paintbrush, apply a thin/light coat of white glue to the tag board.
7. Wrap the second strip of tag board around the first layer in the reverse direction. See figure 2. Wrap the second strip of tag board so it overlaps the seams of the first strip. Again, be careful in forming this layer that the edges butt together and do not overlap. When applying the second layer of tag board, you must be careful because this layer immediately adheres to the first layer. If you make a mistake, you must start over again with step 1.
8. Using the 220-grit abrasive paper, sand the body tube smooth. Use slight pressure while sanding to avoid going through the layers of tag board.
9. Apply a coat of quick-drying sealer to the rocket body tube, and allow time to dry.
10. Make one body tube for each member of your class (make extras in case of damaged tubes).
11. Using an X-acto knife or razor blade, cut the ends of the body tubes, so the ends are square to the dowel rod. See figure 3. The length of the body tube should be 4 inches.

Materials Needed for Launch Lug

Dowel rod (1/8" × 6"), tag board (12" × 12"), masking tape, floor wax, glue, small paintbrush, 220-grit abrasive paper

1. Apply a coat of wax to the dowel rod.
2. Buff the wax-coated dowel rod to a smooth finish.
3. Cut a tag board sheet into 1/4" x 12" strips (edges must be parallel). You need two strips for each body tube.
4. You are going to form a spiral around the dowel rod using the tag board. To do this, tape one end of the tag board to the end of the dowel rod at an angle. Wrap the tag board around the dowel rod, being careful that each edge of the tag board butts together. Leave no gaps, and do not overlap the edges of the tag board. See figure 4.
5. After wrapping the strip of tag board the length of the dowel rod, tape the other end of the tag board to the dowel rod.
6. Using a small paintbrush, apply a thin/light coat of white glue to the tag board.
7. Wrap the second strip of tag board around the first layer in the reverse direction. See figure 5. Wrap the second strip of tag board so it overlaps the

seams of the first strip. Again, be careful in forming this layer so the edges butt together and do not overlap. When applying the second layer of tag board, you must be careful because this layer immediately adheres to the first layer. If you make a mistake, you must start over again with step 1.

8. Using the 220-grit abrasive paper, sand the launch lug smooth. Use slight pressure while sanding to avoid going through the layers of tag board.
9. Apply a coat of quick-drying sealer to the launch lug, and allow time to dry.
10. Make one launch lug for each member of your class (make extras in case of damaged launch lugs).
11. Using an X-acto knife or razor blade, cut the ends of the launch lug, so the ends are square to the dowel rod. See figure 6. The length of the launch lug should be 2 inches.

Materials Needed for Fins
Balsa wood sheet (1/8" × 1" × 12"), 220-grit abrasive paper, thinned white glue, small paintbrush

1. Using a pattern, trace the fin shape on the balsa wood sheet. The fin should be 4" long by 1" wide (fig. 7).
2. Using an X-acto knife or a razor blade, carefully cut the balsa wood to shape.
3. Cut three fins per rocket.
4. Place the three fins together, and carefully sand the edges.
5. Using a small paintbrush, apply a thin coat of glue to the face surfaces of the fins. Apply glue to only one of the surfaces, and let it dry before painting the second surface. This coat of glue acts as a filler and will make it easier to paint the fins.
6. After the fins have dried, lightly sand the surfaces with the 220-grit abrasive paper. Remove the rough surface made by the glue coating, if time permits, apply a second coat of glue sealer, and resand.

Materials Needed for Nose Cone
Balsa wood block (1" × 1" × 2"), 220-grit abrasive paper, thinned white glue, small paintbrush

1. Using a pencil and a straightedge, locate the center of each end by drawing diagonal lines across the corners. On the end that will take the spur or drive center, drill a small hole, and make a saw cut on each line about 1/8" deep.
2. Using the CNC lathe or any lathe, place the block between the lathe centers. Move the dead center into the block.
3. For most spindle turning, the tool should be just slightly below the center of the work.
4. Using the correct lathe cutting tool, shape the nose cone to 3/4" diameter. About 1/2" from one end, round over this end. The length of the nose cone will be 1-1/2" with 1/4" fitting inside the body tube (see fig. 8).
5. Remove the nose cone from the lathe.
6. Using a small paintbrush, apply a thin coat of glue to the face surfaces of the fins. Apply glue to only one of the surfaces and let it dry before painting the second surface. This coat of glue acts as a filler and will make it easier to paint.
7. After the nose cone has dried, lightly sand the surface with the 220-grit abrasive paper. Remove the rough surface made by the glue coating, if time permits, apply a second coat of glue sealer, and resand.

Assembling the Parts

1. Each student receives one body tube, one nose cone, one launch lug, and three fins. Each student inspects each part for defects and for correct measurements. Replace defective parts with extras from each assembly line.
2. Get the tube marking guide from the instructor.
3. Wrap the guide around the tube, and use a piece of masking tape to hold it in place, then mark the tube at the points indicated. Remove the guide, and return it to the instructor.
4. Draw a straight line connecting each pair of marks. (The easy way to do this is to place the tube along a doorjamb, then draw the lines.)
5. Position and glue the fins on alignment lines one at a time. Let each fin dry several minutes before applying the next fin.
6. Adjust the fins to project straight out from the body tube. Do not set the rocket on the fins while the glue is wet.
7. Glue the launch lug against one of the fins, so that it extends towards the nose cone and is even with the bottom of the body tube.
8. Glue the nose cone about 1/4 inch inside the body tube.
9. Check the completed rocket to ensure that the fins are securely attached to the body tube, and apply an additional coat of glue where the fins touch the body tube.
10. Lightly sand all the rocket parts again to remove excess glue.
11. Choose a color for the body tube and paint. After the body tube dries, choose another color for the fins and nose cone, and paint them.

Evaluation

1. Each group grades their portion of the product. A total of 400 points is available to the group. Within the group, each student assigns a number of points to him/herself and the other group members (not to exceed 100 points per student). The ones who did the majority of work should receive the higher points.
2. Product grading is based on the quality of the finished part. For example:
    a. The launch lug and body tube should be free of wrinkles, and each joint should be tight and the surface smooth.
    b. The nose cone should be to the exact dimensions, the surface smooth, and fit snugly in the body tube.
    c. The fins should be smooth, edges square, and match the pattern.
3. For the individual rockets, the fins should be square to the body, the finish on the rocket should be uniform, and the rocket should stand straight.
4. For the flight grades, the rocket should not "spin," at the apex of the flight the rocket should "arc over," and the rocket should survive the landing with little or no damage.

Figure 1

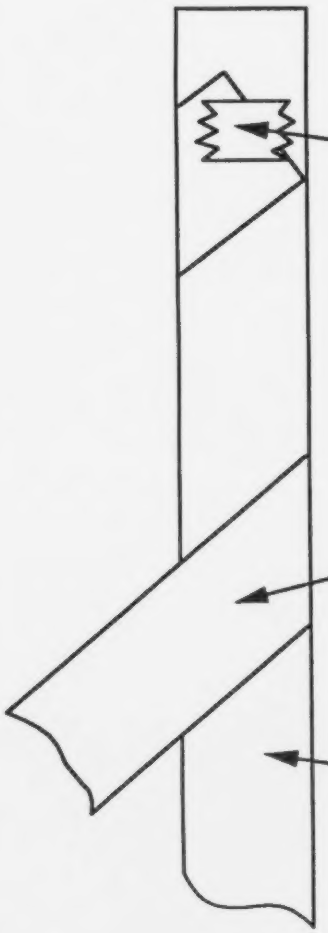


Figure 2

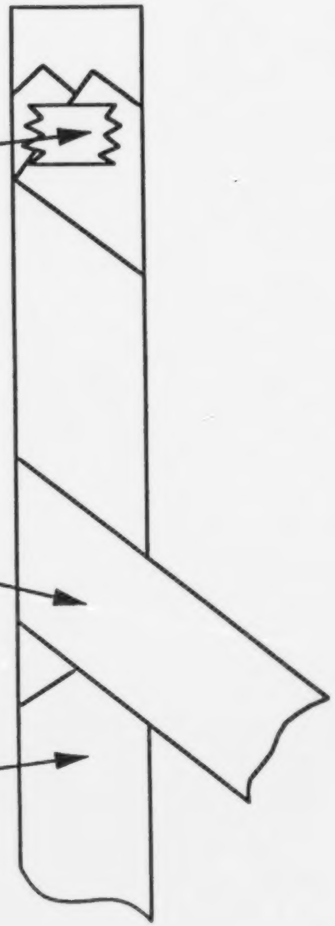

Tape
Tag Board
Dowel Rod

Figure 3

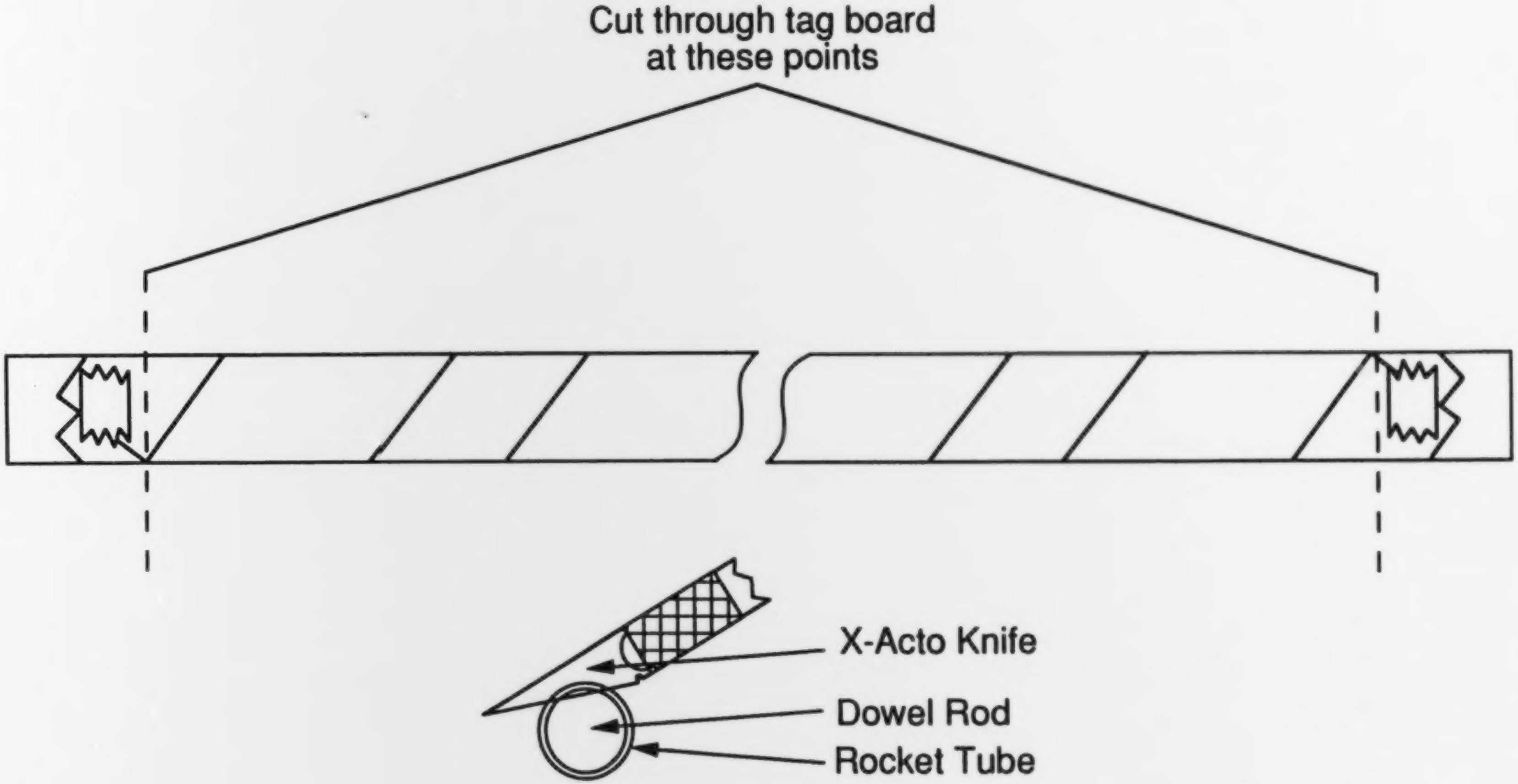

Cut through tag board at these points
X-Acto Knife
Dowel Rod
Rocket Tube

Figure 4

Figure 5

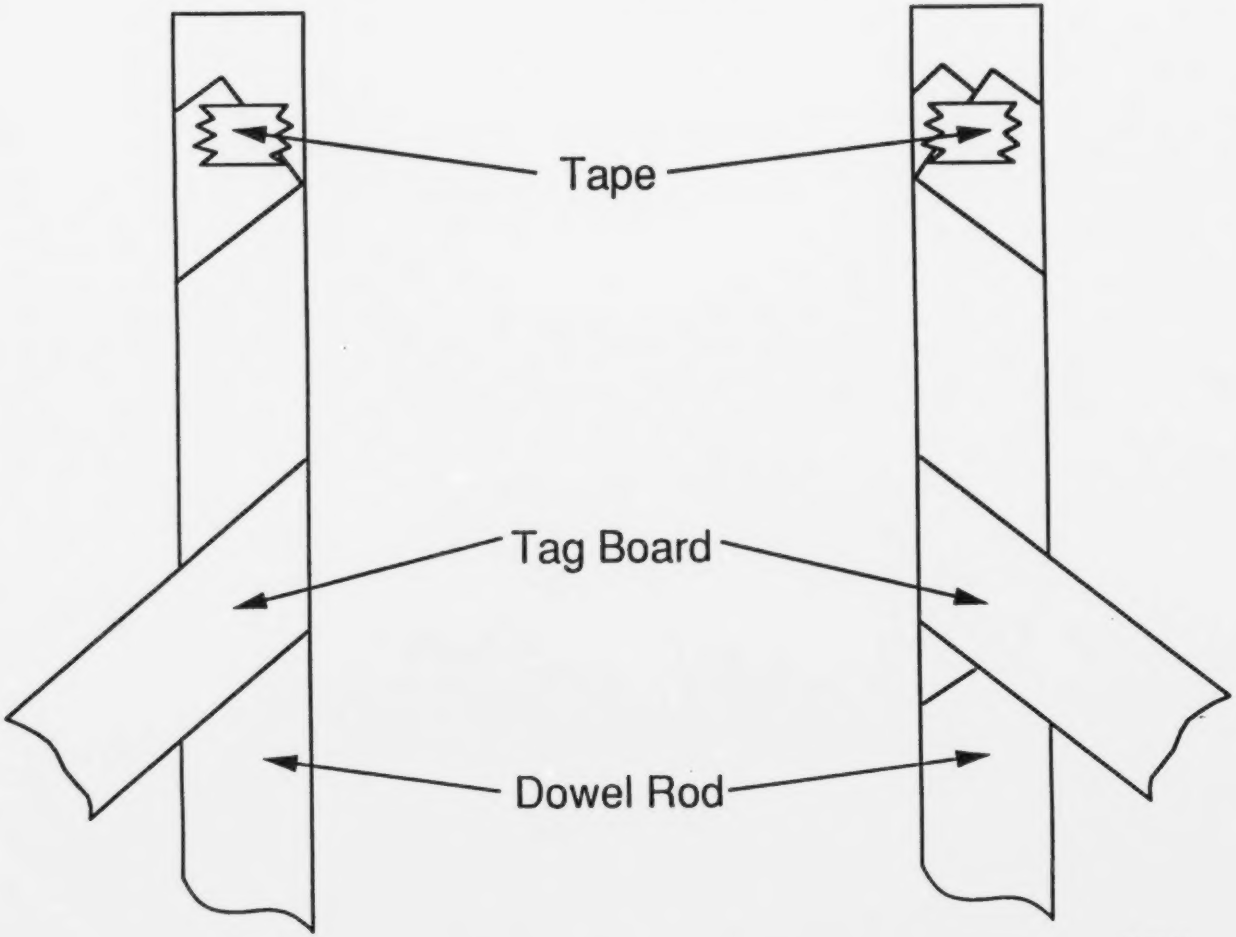

Tape
Tag Board
Dowel Rod

Figure 6

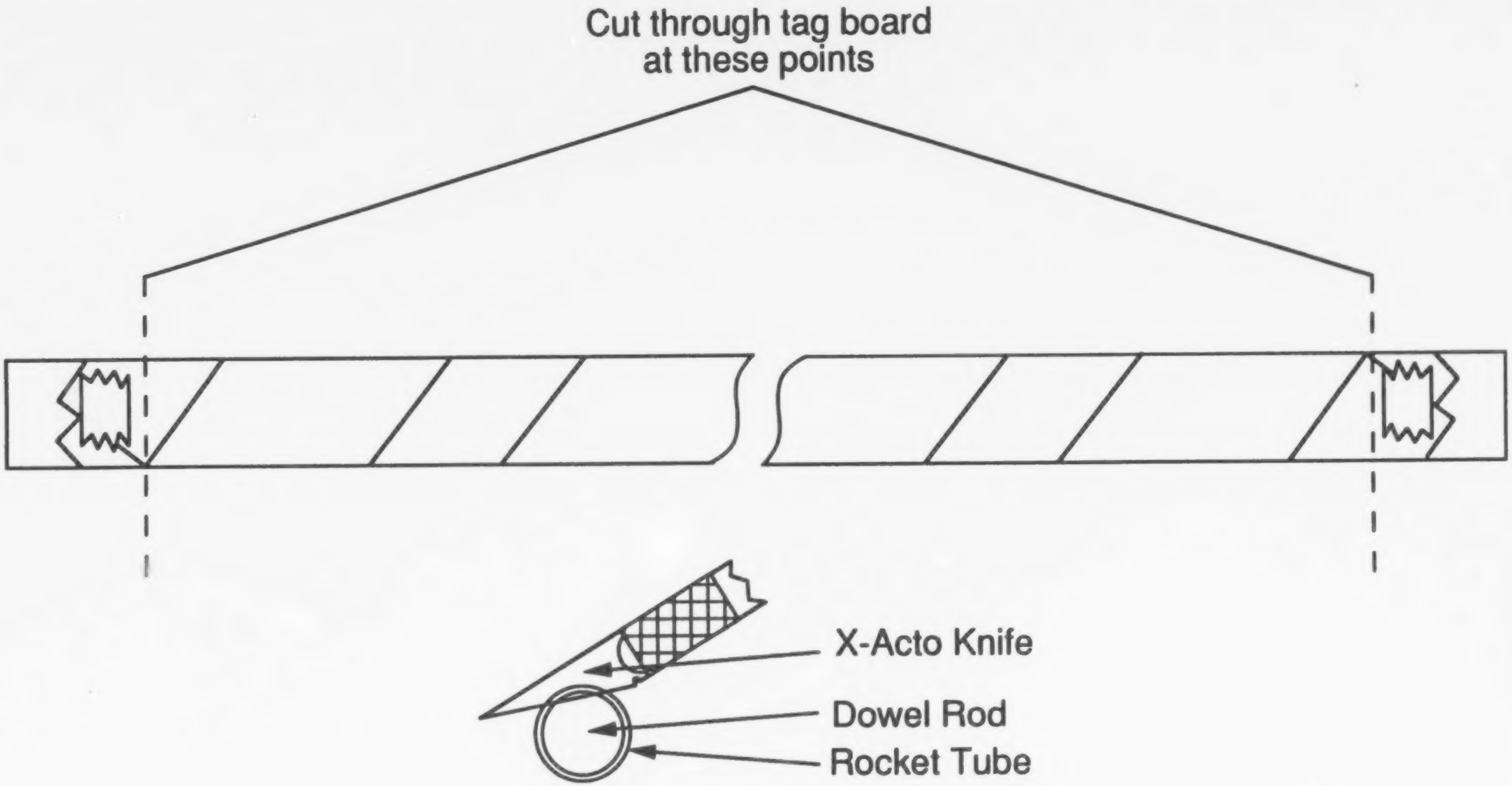

Cut through tag board at these points
X-Acto Knife
Dowel Rod
Rocket Tube

Figure 7

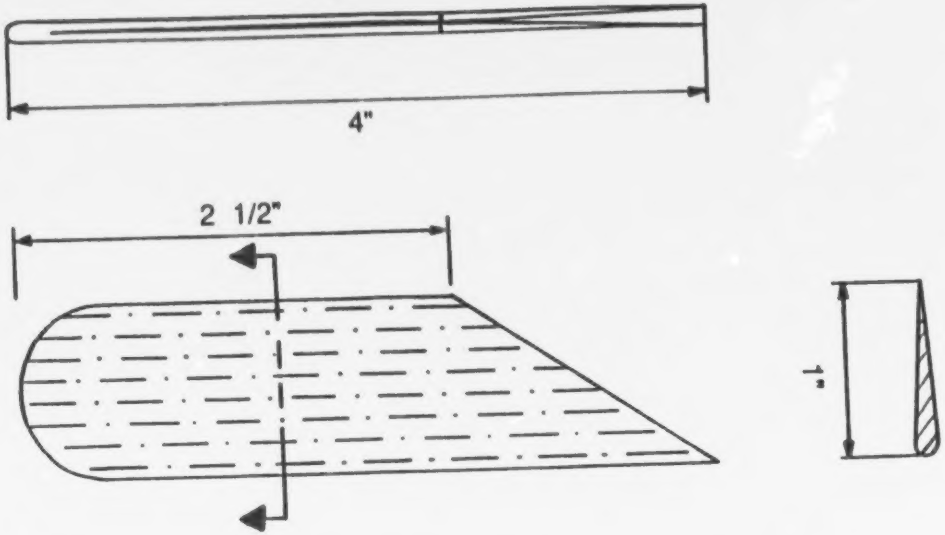
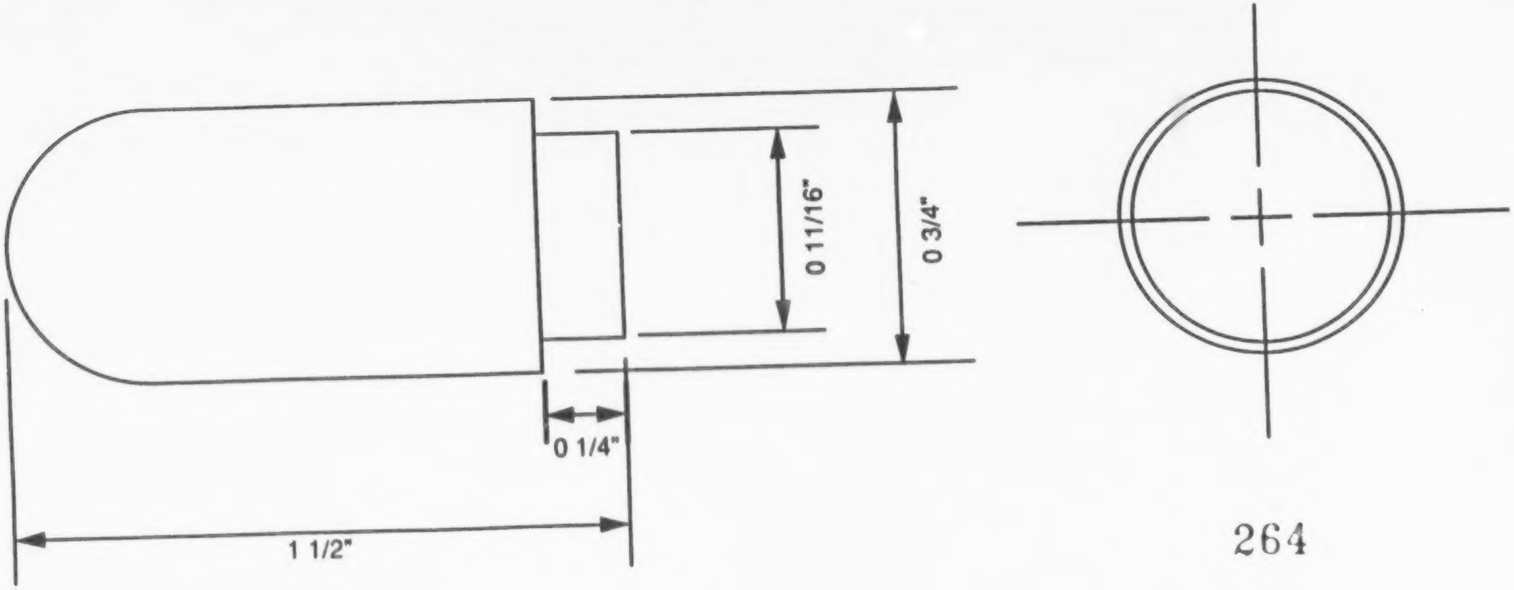
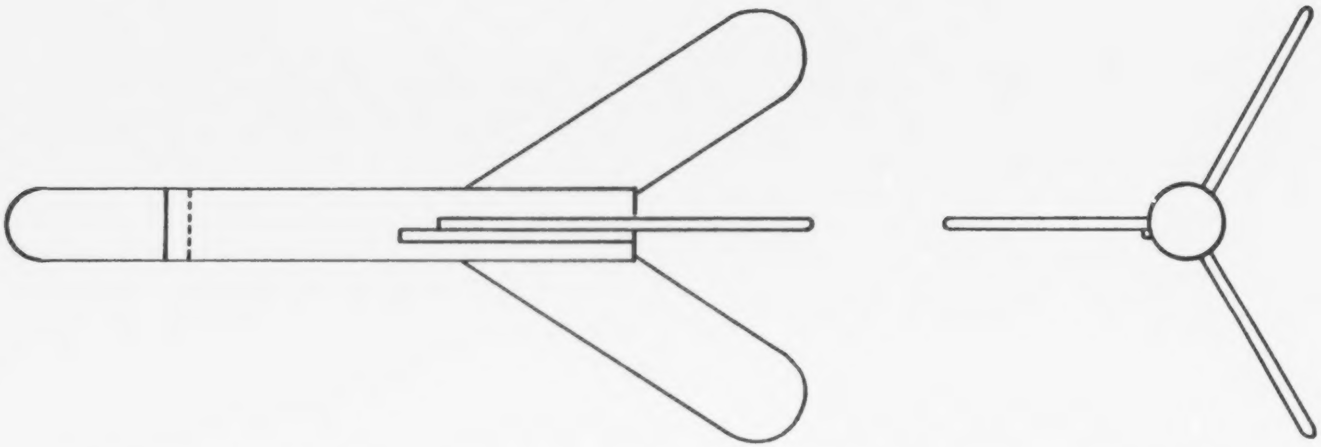


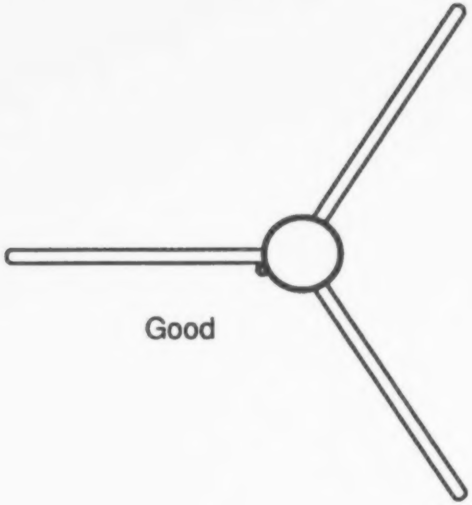
Figure 8


0 11/16"
0 3/4"
0 1/4"
1 1/2"

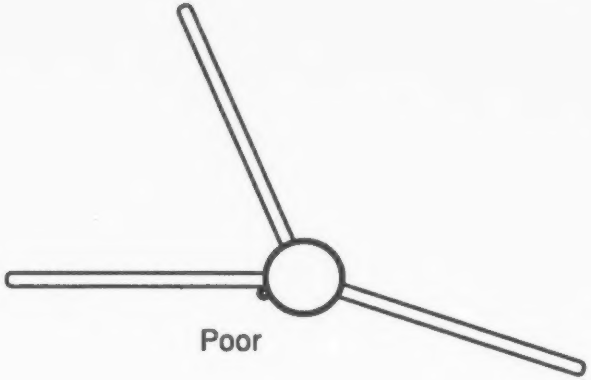
264

263





Good



Poor

FIN ALIGNMENT

RESOURCE RECOVERY AND REUSE

Essential Elements	75.50(b): 2C, 2D, 6A, 6C-E, 7A, 7B, 8A, 8B 75.50(f): 1, 2, 4, 6, 12, 14, 16
TAAS Objectives	Language Arts: RC 1-6; WC 1-4 Mathematics: C 1-4

Activity Overview
You will learn about the advantages of recycling and the uses for recycled materials. Using this information, you will survey your home for reusable products and will research recovery and reuse efforts in your community.

Challenge Statement
Skin cancer and a decrease in oxygen, caused by a hole in the ozone resulting from air pollution and the destruction of our rain forests, are just two problems that could be lessened by recovering and reusing our resources, commonly known as recycling. Everyone has heard about recycling, but not everyone realizes its importance and practices it.

What are the advantages of recovery, and how can recycled materials be reused? This activity will encourage your students to use their imaginations to design useful or fun products or structures from recycled materials.

Systems Model
Resources
Students as learners and designers
Teacher as resource person and moderator
Current events articles
Handouts

Processes
Reading and discussing new information
Surveying home recycling practices
Evaluating personal responsibility toward recycling
Applying recycling information
Imagining products or structures from recycled materials
Describing products or structures in writing, pictorially, and orally

Applications
Personal awareness to social responsibility
Technological knowledge to resource recovery and use
Creative problem solving to real-world problems

Impact
Environmental consciousness
Responsible, personal recycling habits

Interfacing with Other Disciplines

Language Arts: Students will learn new words and concepts. They will give a written description of creative solutions to recycling problems.
Mathematics: Students will understand the problem of waste disposal, recovery, and reuse in numerical terms.
Science: Students will understand the impact of using recycled materials rather than using up our raw materials.
Social Studies: Students will understand the impact of waste disposal and the need for personal responsibility through recycling.

Critical Thinking Skills Reinforced

Students will learn how to apply personal and societal solutions to a world problem. They will understand the growing problem of waste disposal, and apply recovery and recycled materials to develop a product or situation for reuse.

Teaching Tips

1. It will be important to have current information on the reuse of recycled materials as technology is changing rapidly. Your school librarian would be a good resource person for this activity.
2. Have a transparency of the Conservation Through Recycling handout to review with the class. Emphasize the savings to society, the environment, and ourselves through reuse. Stress personal responsibility through recycling.
3. Here is a list of "things to do" to help your students with their brainstorming activity. This was taken from *The Technology Teacher*, May/June 1991.

Simple Things You Can Do To Help the Environment

- Buy recycled products whenever possible, and select ones with minimal and recyclable packaging.
- Limit your use of disposable items. For example, substitute reusable or electric razors, refillable ballpoint pens, and rechargeable batteries for their disposable alternatives.
- Try to use products that are recyclable in your own community.
- Buy soap bars rather than liquid soap in disposable plastic pump bottles.
- Bring your own reusable bags to the grocery store rather than using theirs. When they are worn out, recycle brown paper bags as cardboard.
- Buy bulk products rather than small or individually wrapped servings.
- Whenever possible, use rags or sponges instead of disposable paper towels and napkins.
- Compost organic waste.
- Use two-sided copies.
- Recycle all aluminum, glass, paper, HDPE, and PETE plastic and oil.

(Credit: Michael Benedetto, Tidewater Fibre Corp.)

4. The *Recycled Products Guide* (RPG) is a publication that lists about 2,900 certified products made from recycled materials. These listings come from 400 different recycled product classifications. The publication is updated semiannually, increasing the listings by roughly 30 percent each issue. The book is compiled by a twelve-member advisory board from the government and private sectors. Because the publication costs $150, you may want to use a library copy for information on current reuse products.

Instructional Strategy

- Plan this unit carefully to establish a strong purpose in the students in the area of reusing our raw materials.
- Review the written materials, and discuss the impact of continued random wastes.
- Involve the learner through imaginative drawings and descriptions.
- Evaluate the drawings positively to encouraged participation in a recycling program.

Equipment/Supplies
1. Energy Conservation Through Recycling handout
2. Current technology articles

Evaluation Key
Evaluate students on their creativity and presentation of their design.

Support Materials
"Redefining the 3 R's, Reduce—Reuse—Recycle," *The Technology Teacher,* May/June 1991.

Modifications for Handicapped, Disadvantaged, and LEP Students
Some students may need additional time and suggestions with their creative designs.

Conservation Through Recycling

Material	**Savings through recovery and reuse**
Paper	60% less energy is used to make newsprint from recycled paper. Water pollution is reduced 35%. Air pollution is reduced 74%. A bale of paper (about 4' x16') will save at least 17 trees.
Metals	
Aluminum	Producing one ton of aluminum from recycled aluminum takes 85.6 times fewer kilowatt-hours of electricity than from ore.
Steel	Almost 66% of production energy can be saved by recycling
Copper	One-tenth the energy is used to produce copper from scrap metal.
Glass	One third of the energy is saved by using recycled glass.
Plastics	Recycling saves nonrenewable resources.

Impact

Energy, processes, and time are saved by using recycled materials in production. This savings requires less money to process raw materials and pay employees. The savings in processes also saves the environment from excessive pollution of our water and air.

Home Survey

1. What kinds of plastics do you have in your home? ______________________________
   Do you recycle plastics? ______________________________
   How many have the recyclable symbol? ______________________________
2. What products in your home are in glass containers? ______________________________
   Do you recycle glass? ______________________
3. Does your household receive the newspaper? __________Do you recycle? __________
4. Do you have a computer at home? ______Do you recycle waste computer paper? ________
5. Does your household consume drinks in individual cans? ______Do you recycle? ______
6. If you do not recycle, why not? ______________________________
   ____
   ____
7. How could you begin? Write your answer on the back of this page.

Evaluation Sheet

Choose one of the groupings below. Design a product or structure that you would make from the recycled materials. You must use all of the materials in the list, but you can determine the product /products the materials will be made into.

A. Paper, plastic, and fabric

B. Plastic, glass and metal

C. Plastic, rubber and metal

D. Paper, glass, and rubber

E. Optional—Choose three materials listed in the Introduction.

I chose group_____ which includes____.

Describe your creation in writing.____

____

____

____

____

____

Sketch your creation below.

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RESOURCE RECOVERY AND REUSE

Learn about the advantages of recycling and the uses for recycled materials, then survey your home for reusable products, research recovery and reuse efforts in your community, and design a structure or product using a grouping of recycled materials.

Challenge Statement

Skin cancer and a decrease in oxygen, caused by a hole in the ozone as a result of air pollution and the destruction of our rain forests, are just two problems that could be lessened by recovering and reusing our resources, commonly known as recycling. Everyone has heard about recycling, but not everyone realizes its importance and practices it.

What are the advantages of recovery, and how can recycled materials be reused?

Objectives

- To understand the advantages of recycling
- To learn how to recycle in your community
- To become aware of the many uses of recycled products
- To creatively design a product or structure from recycled materials

Vocabulary/Concepts Reinforced

- Direct recycling
- Indirect recycling
- Reuse

Equipment/Supplies

- Energy Conservation Through Recycling handout
- Current technology articles

Introduction

Have you thrown away anything today? Multiply your garbage by 200 million to get an idea of the waste problem we have. Could you have recycled what you discarded? Why didn't you? The reasons you give are the obstacles we need to overcome to begin to reclaim and reuse our wasted resources.

Americans recycle only 10 percent of the 160 million tons of garbage thrown out annually! Most of the garbage in landfills is paper and cardboard that can be reused. This accounts for 38 percent of our waste. Look around your school, and think about the notebook and computer paper thrown out. Multiply that mound of paper by all the schools and office buildings in the world, and you have a mountain. Add to that all the newspapers that are not recycled, and you have a mountain range! Imagine the trees, clean air and water, and landfill space that can be saved by reusing that 38 percent.

What about the other 62 percent of garbage? Where does it come from? Well, 25 to 30 percent of it is glass. Although glass is easily recycled and reused, it still takes up a large portion of landfill space. Plastics take up a little less than 20 percent and metals about 15 percent.

Let us imagine, ideally, that everyone would be responsible to themselves, each other, and the environment, and would recycle everything reusable. We could reduce our waste by: 38% paper and cardboard + 25% glass + 19% plastics + 15% metals = 97%.

We can look at 97% and know that that is not going to happen, because not everyone will recycle. The question is, *"Will you?"*

There are basically five advantages to society to recover our resources:

1. Conserve energy
2. Less waste in landfills and oceans
3. Less dependence on foreign countries for resources
4. Save the environment

Most industrial materials and product begin as a raw material. To extract, harvest, mine, or pump, then transport and process the material into a usable material, requires large amounts of energy. By reusing raw materials we save significant energy.

Landfills are becoming an increasing concern, not only because of the diminishing space, but also because of the dangerous gases being released into the air. Options for waste disposal have not been good. Some countries have resorted to dumping their wastes into the oceans. We have realized the worst of that solution from seeing our beaches covered with plastic and glass. (See the activity, "Whose Turn Is It to Take Out the Garbage?")

Many of our resources are not only nonrenewable, but scarce in the United States. As we run out of our limited resources, we are required to go overseas to restock. By recovering and reusing products containing these resources, we save a limited resource and gain independence from foreign sources.

Environmentally, recycling is not an option, it is a must! We are depleting our nonrenewable resources and stretching our renewable ones. We just have to look at the rapidly deteriorating quality of our air and water to know we have to make changes in production, consumption, and waste disposal. What are some environmental concerns that are a result of improper waste disposal?

Okay, let's say everyone will recycle. How will we use the recovered resources? There are three types of resource recovery. The first is the simplest and most effective called *reuse*. These products are basically returnable, such as drink bottles which are returned for a refund, then cleaned, inspected, and refilled. This process the most energy and processes in production. Other reusable items are automotive parts that can be rebuilt.

Another type of recycling is *direct recycling*, which involves industry buying back the resource to remake it into the same product. The best example is aluminum cans. Since 1967, R. J. Reynolds Aluminum Company has paid $400 million to recyclers for 2 billion pounds of aluminum. This accounts for almost 50 billion drink cans. This is a very effective use of our resources.

The last and most common type of recycling is *indirect recycling*. Often materials cannot be remade into the same item but will be used for other purposes. The manufacturer just intends to keep the resource in production. Hundreds of new products are made from these reclaimed products.

Paper is a good example of indirect recycling. The United States uses about 12 million tons of recycled paper annually to make paper products from bathroom tissue to stationery. Much of our waste paper is exported overseas for reprocessing. Used paper is New York City's largest export. Reusing used paper saves trees and our oxygen source.

The earliest material recycled was metal. Metals are easily melted down and reshaped for production. They represent a nonrenewable resource which makes them ideal for recycling. Iron and steel lend themselves best to recycling for automotive parts, tools. construction materials, appliances, and cans.

Rubber is unique because it is not cost-effective to break down for reuse, but can be used for ground-up particles in road surfaces, building materials, playground equipment, and even soles of shoes. Old rubber tires can be melted down to produce oil and gas. Rubber can be burned as a controlled heat source.

Plastics offer a wide range of options for reuse. According to Mike and Brenda O'Keefe, owners of Superseded Recycled Alternatives, Inc., in Dallas, there are roughly four hundred categories of items made from recycled plastic, from lumber to carpet and wallpaper.

Other recyclable materials are copper, lead, aluminum, textiles, and oil. Can you identify these as reusable, directly recyclable, or indirectly recyclable?

Procedure

1. Read and discuss the Introduction. Review current events articles on innovative uses for recycled materials.
2. Review and discuss the information on the Conservation Through Recycling form. Complete the Home Survey on the bottom of the sheet.
3. Bring products from home that can be recycled. Highlight the recycle symbol. Identify the category of recycling (reuse, direct, or indirect).
4. Complete the Evaluation Sheet. Your teacher will give you standards for your drawing. If you have a CADD system available, use it. Your creation can be for any time frame. You can design something that could have been used in the past (*Back to the Future* style), something that can be used today, or something for use in the future on earth or in outer space.
5. Share your invention with the class. Display your drawing.
6. As a class, brainstorm ten simple things you can do to help the environment. Neatly write your list to display in the classroom and the school.

Evaluation

You will be graded on your creativity and presentation of your design.

EXPERIENCING ENTREPRENEURSHIP

Essential Elements:	75.50 (b): All 75.50 (f): 1, 2,13, 14, 17 75.50 (g): 1A-D, 1F, 1G 75.50(i): 4, 8, 10, 13
TAAS Objectives:	Language Arts: RC 1, 2, 3, 5, 6 Mathematics: C 1-5; O 1-4; PS 1-4

Activity Overview

The class will organize itself into a working company. Students will set up the company with an elected board of officers and a product that they will design, market, and sell. You will fund the company by selling stock within the class, and your students will apply for jobs to run the company and produce the product. They will then set up the lab as a mass-production factory, terminate the company after six weeks, and divide the profit among shareholders, if that is permitted at your school.

Challenge Statement Explanation

As much as 95 percent of new businesses fail within the first five years. This tells us that only a very small percentage of people are properly prepared to go into business for themselves, yet many people try unsuccessfully.

Educators should take an active role in helping to train the entrepreneurs of the future. Many business problems can be avoided with an understanding of all that is involved in a business structure, and industrial technology education has the resources needed to do this. This unit will give your students an overview of all the details of owning and running a business as a corporation. It will help them decide if they would like to own a business one day and hopefully prepare them for the task ahead.

Systems Model

Resources
Instructor as resource person, monitor, and evaluator
Students as stockholders, managers, and employees
Technology classroom as boardroom and business offices
Technology lab as production plant

Processes
Discussing new terms and concepts
Brainstorming product ideas
Organizing a corporate structure
Electing the management staff
Designing a product
Applying for jobs
Manufacturing a product
Managing business finances
Marketing a product
Evaluating and closing a company

Applications
Business terms and concepts to a controlled learning environment
Organizational skills to business
Management skills to business
Design skills to business
Math skills to business finances
Creative skills to design and advertising

Impact
Career choices
Business ownership and awareness
Business finances
Product awareness
Capitalism

Interfacing with Other Disciplines

Language Arts:	By creating advertisements for products designed, the technology education students will learn how advertisers use language to their best advantage.
Math:	Students will use problem-solving skills to determine the expenses and break-even point of the companies. They will keep accurate, ongoing records of all business transactions.
Science:	Using the scientific method, students will isolate a given problem and invent a solution. The solution will be in the form of a new product Other Disciplines that can make life easier.
Social Studies:	Students will study the impact of business and industry on society. They will have a better understanding of job options and requirements.

Critical Thinking Skills Reinforced

Students will engage in a comprehensive learning experience about business through the development, organization, and management of a corporation. They will apply business knowledge to an actual problem-solving experience to analysis and evaluate which will allow them to apply insight to their career choices and career values.

Teaching Tips

1. Before the unit begins, carefully read the Procedure on the student activity sheet. It will give you an overall perspective of the direction the unit will take. Once the students realize the objectives, and their goal is clear, your job will simply be monitoring. The first time you teach this unit, you may be a little apprehensive, because of the scope, but you will be amazed at your students' work once they realize they own the company.
2. The movie, *Tucker*, will allow them to get an understanding of the complexity of business. This will help prepare them for all the details and management that will be required in their own companies.
3. It is extremely important that the class realize the significant role the officers play in the success of the corporation. Emphasize the responsibility involved with being an officer without scaring them away. Relate successful officers to known businesses, as Iococca to Chrysler. Stress that this is a business decision and not a popularity contest. Your job will also be easier with good officers.
4. The more responsibility the class feels for the corporation, the more smoothly the company will run. Help the students realize the difference between owner and employee attitudes toward the company. Try to instill the team concept into the production line; every job is necessary to the success of the corporation, and if an employee doesn't do her/his job well, the corporation and each student loses money.

5. Closely monitor and secure the money. You will charge the class a 10 percent overhead fee for the use of the equipment and facility. Relate this cost to overhead in business. The unit "Financial Overview" gives a good explanation of overhead costs and includes a student worksheet. The units "Marketing Overview" and "The Work Process" can all be incorporated into this unit.
6. You will need to get permission from your principal to sell stock in your class. If you are not allowed to use real money, you will still issue stock certificates, but you will need to determine a system for returning "profits" to your students.
7. A number of forms are included with this unit. The students can use these or design their own.

Instructional Strategy

- Open the unit by introducing new terms and concepts through lecture and discussion.
- Then monitor the students as they view and evaluate the video *Tucker*.
- Specify the learning objectives and sequence the learning activities for the students.
- Monitor and guide the students, and adjust their activities as the corporation develops and operates.
- Close the unit with an evaluation of their product and profits, applying their experience to a real world setting.

Evaluation Key

In this type of unit, participation from all students is critical, and they should be held accountable. Because of the degree of activity involved, it would be difficult to keep a daily grade for each student. Assign a daily participation grade of 100 for each student. If a student is not staying on task or is distracting other students from their work, deduct points as you feel appropriate. Mark this deduction in your grade book immediately. At the end of the unit, determine the total points deducted and divide the total by the number of days the student received deductions. For example:

M	T	W	Th	F	M	T	W	Th	F
	-5			-15	-50				-10

5 +15 + 50 + 10 = 80 (divided by) 4 days of misbehavior = 20 points deducted
100 points - 20 points = **80 daily work grade**

Explain this system to your students before they elect officers. They may argue that you are not averaging in their good days equally, and therefore the system is not fair. Point out that if you do not stay on task at a job for four days out of ten, you would possibly loose your job.

Equipment/Supplies

1. Flow Process Chart
2. Operation Sheet
3. Bill of Materials
4. Preliminary Costs Estimates
5. Break-Even Graph
6. Application Form

Support Materials

1. Fales, James, et al. *Manufacturing: A Basic Text for Industrial Arts*. Bloomington, Ill.: McKnight and McKnight, 1980.
2. *Tucker: A Man and His Dream* (video movie)

Modifications for Handicapped, Disadvantaged, and LEP Students

No modifications are necessary as the students are working in a group setting and will apply for jobs appropriate to their abilities.

FLOW PROCESS CHART

Name ____________________

Date ____________ Score ____________

PRODUCT NAME	FLOW BEGINS	FLOW ENDS	DATE
PREPARED BY:	SECTION:	APPROVED BY:	
PROCESS SYMBOLS AND NO. USED	○ OPERATIONS ______ □ INSPECTIONS ______ ⇦ TRANSPORTATIONS ______ D DELAYS ______ ▽ STORAGES ______		

Task No.	Process Symbols	Description of Task	Machine Required	Tooling Required
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
	○ ⇨ □ D ▽			
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OPERATION SHEET

<table>
<tr><td colspan="5">Job Description</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Step No.</td><td>Description of Operation</td><td>Machine</td><td>Tools and Equipment</td><td>Materials</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
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PRELIMINARY COST ESTIMATE

Name ______________

QUANTITY	PART OF ITEM	VENDOR A	VENDOR B	VENDOR C	BEST PRICE

VENDOR'S NAMES: A: ____________ B: ____________ C: ____________

BILL OF MATERIALS

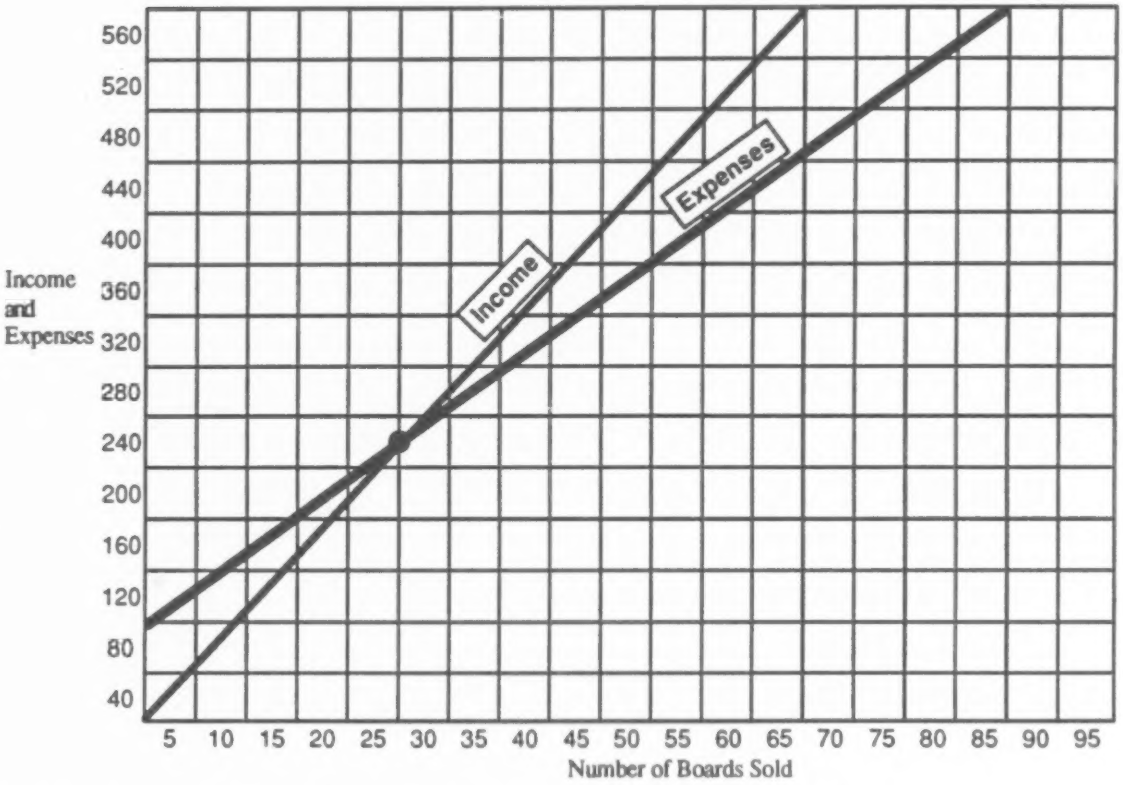
Name ______________________

PRODUCT: ______________

PART NO.	NUMBER NEEDED	PART NAME	SIZE			MATERIAL
			T x	W x	L	

The following example was compiled by Jason Fry of Noel Grisham Middle School in Round Rock, Texas. The company is called "Clipboard."

Break-Even Graph



Prices ranged from $2.00-$8.00. Initial amount raised for expenses was $80.00.

EXPENSES	
$3.77	Folders (office supplies)
$15.08	Paper, copies, pens (office supplies)
$10.68	Pop rivets
$7.98	Pop rivets
$40.25	Plastic
$31.59	Plastic
$44.55	Plastic
$37.37	Clips
$27.38	Clips
$25.18	Clips
$243.73	TOTAL EXPENSES

INCOME	
4-25-91	10 Boards sold
4-29-91	33 Boards sold
5-10-91	60 Boards sold
5-17-91	72 Boards sold
$572.27	TOTAL INCOME

Application Form

Name____
(Last) (First) (Middle)

Today's Date__________________ Social Security No. ______________________

Address______________________ City ____________________ State __________

Employment Desired

First Choice ______________________________________

Second Choice ______________________________________

Third Choice ______________________________________

Why do you think you would be the best person to do your first choice job?

____

____

____

Work Experience

Job	Employer

References (Adults Only)

	Name	Address	Phone Number
1.			
2.			
3.			

EXPERIENCING ENTREPRENEURSHIP

With your class, organize into a working company, with an elected board of officers and a product that you will design, market, and sell. Fund the company by selling stock within the class, and apply for jobs to run the company and produce the product. Then set up the lab as a mass-production factory, terminate the company after six weeks, and divide the profits among shareholders if the school permits.

Challenge Statement

As much as 95 percent of new businesses fail within the first five years. This tells us that only a very small percentage of people are properly prepared to go into business for themselves, yet many people try unsuccessfully.

Many business problems can be avoided with an understanding of all that is involved in a business structure. This unit will give you an overview of all the details of owning and running a business as a corporation. It will help you decide if you would like to own your own business one day and understand all that is involved in doing so.

Objectives

- To understand the importance of adequate start-up costs in opening a business
- To understand the importance of strong management in a business structure
- To understand the importance of hiring the right person to do a job
- To understand the importance of keeping accurate financial records
- To understand the importance of producing a quality product
- To understand the importance of successfully marketing your product

Vocabulary/Concepts Reinforced

- Assembly line
- Bankrupt
- Brainstorming
- Company officers
- Corporation
- Custom manufacturing
- Entrepreneurship
- Flowchart
- Gross income
- Job application
- Job lot manufacturing
- Line manufacturing
- Logo
- Net income
- Parliamentary procedure
- Partnership
- Profit
- Proprietorship
- Research and development (R&D)
- Shares
- Stockholders
- Stocks
- Tooling up
- Trademark

Equipment and Supplies

- A basic school classroom with a technology lab and manufacturing equipment
- VCR and TV

Introduction

In 1900, 90 percent of adults owned their own businesses, and 10 percent were employees. Today those numbers are reversed, and 10 percent are business owners, and 90 percent are employees. The industrial revolution lured thousands of workers from farms and small towns to factory towns in the hope of increased income and a better way of life.

Now in the 1990s, workers are experiencing a great deal of frustration and job insecurity working for someone else. Many of these people want to earn back their freedom by being in business for themselves, but do not have the knowledge necessary to run a successful business.

This unit is designed to help you experience all the aspects of working in and running a small business on a short-term basis.

Procedure

1. Your teacher will present an introduction to entrepreneurship—what it means; how you are affected by it; how your local economy and your country are affected; capitalism vs. other economic systems in the world. Answer the question, who are entrepreneurs?
2. Discuss the development of the manufacturing process, beginning with the Industrial Revolution. Include working conditions in factories, manufacturing in the United States, the assembly line, automation, recycling and energy conservation, and manufacturing in the future.
3. View the movie *Tucker: A Man and His Dream*, starring Jeff Bridges. This is the story about the Tucker automobile in the 1940s. Before the end of each class, review the advantages and disadvantages of owning your own business.
4. Review the movie *Tucker*. What were some of the problems Tucker had? What could have made a difference in the manufacturing of his car? Give some of the outside variables that had an effect on his business.
5. Discuss great entrepreneurs in our country (e.g., Steve Jobs, Ray Kroc, Milton Hershey). If you have a parent or relative in business for themselves, share the information with the class.
6. Discuss these questions: What is the manufacturing industry (people, tools, materials, and processes)? What would America's economy be without the manufacturing industry?
7. Describe the types of business ownership—sole proprietorship, partnership, and corporation. Discuss the roles of management, administration, and stockholders. Discuss the necessity of teamwork in this project. Begin to think of the role you would like to have in the manufacturing process.
8. With your class, discuss the organization of the company, naming the different officers and explaining their responsibilities:
   a. President—CEO, and in charge of design
   b. Vice-president—in charge of personnel
   c. Treasurer—financial officer who will keep records of all the income and expenditures
   d. Secretary—in charge of public relations and advertising

   The officers will also hold manufacturing jobs. The treasurer will have to be flexible, as he/she will have daily finances to manage. Think carefully about these positions. You may feel you can do a good job and would like to be an officer.
9. This election cannot be a popularity contest. The success of your investment rests on the people who manage it. They must be honest, capable, and serious about the company. On election day, the class will vote on candidates running for the four offices. Each candidate will have the opportunity to give a two-minute speech. Listen carefully to their reasons for wanting to be involved in management and remember the responsibility of their job. Evaluate their qualifications, and vote wisely.

10. Discuss research and development: where ideas come from, brainstorming, and why R&D is important. (Example: Brainstorm a new energy source of the future.)
    There are three tasks for the next two to three days:
    a. Brainstorming product ideas: The elected president will take charge of brainstorming ideas for products that your company could manufacture. Have the vice-president write the design ideas on the board as the class brainstorms.
    b. Selecting the product: The class will vote on which product to manufacture, and the majority will rule.
    c. Choosing a company name: After the product has been selected, the class will come up with a company name.
11. Discuss the importance of the proper design and engineering of products for safety and quality. The class will choose
    a. a design committee to work with the president to present final design drawings of the product for a class vote;
    b. a finance committee to work with the treasurer;
    c. a personnel committee to work with the vice-president; and
    d. a marketing committee to work on advertising and a company logo. The secretary will head this committee.
12. a. The treasurer and his/her committee will call local businesses for prices of materials to determine the cost of the product.
    b. The president and her/his design committee will work on design drawings.
    c. The vice-president will work with his or her committee to design a job application and determine which jobs need to be filled to produce the class product.
    d. The secretary and his/her committee will work on advertising and a company logo to be approved by a class vote. The students need to have at least three choices for the class to chose from.
    e. The remainder of the students will check the lab for proper tools and equipment set up.
13. With the president presiding over the meetings, all committees will present reports on their work.
    a. The finance committee will report on (1) product cost; (2) amount of stock needed to start production (depending upon the product, $100 is a good start); (3) the price of each share ($1.00); (4) product retail cost (to be voted on by the class); and (5) possibility of a bonus or commission and, if so, in what amount (to be voted on by the class).
    b. The design committee will submit the proposed designs, and the class will vote to select one.
14. a. The design committee will finalize drawings (with dimensions) and produce a flowchart.
    b. The personnel committee will work with the design committee to determine the jobs necessary for production. Your instructor will discuss job applications with the entire class. A list of the available jobs will be taken from the flowchart and listed on the chalkboard.
        - Each student will fill out a complete job application, indicating first, second, and third job choices. Remember, your job application is your job interviewer's first impression of you. The officers will interview each student for the specific job for which he/she is applying and decide who gets it. The officers will place every student in a job. (Every student, including the officers, must have a job.) The treasurer will be in charge of quality control. His or her daily work time will be limited to be free to handle the money from sales.

   c. The finance committee will (1) issue stock at $1.00 a share (if there are shares left over, take the number of shares left and allow the students who so desire to draw for the right to buy the remaining share); (2) fill out stock certificates for each share sold; and (3) set up a spreadsheet for expenses and expenditures. If possible, keep all these records on computer.
   d. The marketing committee will design advertising to present to the class for approval.

15. Start sales and production. All the students will go out and sell their product after school. Sales will continue for two weeks. An accurate count should be kept for production and finance. Each student will be responsible for collecting the money for the products individually sold.
    The industrial technology lab will be set up as a mass-production unit. Each student will do his/her assigned job in the production line. Each student should be concerned about quality control. As more sales come in, more supplies and materials will be needed. The officers of the company are responsible for all incoming and outgoing orders, correct accounting of money, operation of a smoothly running mass-production line, and a master sales list for commissions and bonuses (optional). The students will have roughly three-and-a-half weeks in actual production. Each student is held responsible for his/her own job on the production line.
16. Closing down. All production should be stopped. All orders should be filled and delivered to the customers. All bills should be paid, including those for materials and supplies, commissions, and bonuses. (The company will pay the technology department a 10% overhead cost from the gross product sales for use of the industrial technology lab.) After everything is paid, the net is divided by the number of shares in the company. This amount will be paid to each of the individual shareholders. The treasurer will present the company's financial status to the class. He/she will give an in-depth report of all income and operating expenses through a break-even graph to visually demonstrate income and expenses.
17. The class will evaluate the company to determine the pros and cons of forming a company. You will discuss what it takes to run a company successfully. Realize that once a company is started, sole proprietorships, partnerships, and corporations are run basically the same way. The main difference between them is in who owns the company and who makes the decisions.

Evaluation

- Your cooperation and participation during the entire unit will be weighted heavily. Your teacher will explain how you will be graded for participation.
- Your evaluation will be based directly on the class's performance in sales, design of the product to be sold, and quality of workmanship.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 31
(5-6 DAYS)

DESIGNING DEVICES TO HELP PEOPLE WITH DISABILITIES

Essential Elements:	75.50(b): 1A, 2C, 2D, 6A, 6B, 6D, 6E, 7B, 8A, 8B 75.50(f): 1, 2, 6, 17 75.50(g): 1A, 1B, 1F, 1G, 1H
TAAS Objectives:	Language Arts: RC 1, 2, 4, 5, 6; WC 1-4 Mathematics: C 1-4; PS 1-4

Activity Overview

Your students will be assigned a disability to role-play to help them realize the limitations that disabled people experience. After they have developed an appreciation of their situation, they will design devices to help those with disabilities.

Challenge Statement

You've had a terrible accident. Things that were so easy for you before are nearly impossible now—simple things like eating, brushing your teeth, talking on the phone, or going shopping. Now you must rely on others for help and on the advances made in technology that will replace some of the functions that you took for granted.

In order to have an appreciation for the condition of a special needs population, your students will need to experience, even in a limited way, some of the challenges and frustrations for disabled individuals. From this insight they will be better able to imagine other limitations. Their designs will be a solution for the challenges they experience and imagine.

Systems Model

Resources
Prior knowledge of robots and computers
Students as individuals with disabilities, designers, and engineers
Imagined limitations through role-playing
Instructor as moderator

Processes
Role-playing
Imagining
Designing
Sketching
Reporting

Applications
Imagining to problem solving
Brainstorming and teamwork to problem solving
Creative design to problem solving
Sketching to the design process
Technological innovations to solutions for disabled individuals

Impact

Understanding of and empathy for disabled people
Creative problem solving
Technological innovations as solutions to problems

Interfacing with Other Disciplines

Language Arts:	Students will use imagining to develop an understanding of people with handicaps. They will use this understanding to solve a problem and report the solutions both in writing and orally.
Mathematics:	Students will solve a problem and present their solutions with drawings and measurements.
Science:	Students will understand the relationship between biological problems and physical limitations.
Social Studies:	Through role-playing, students will develop an understanding of people with disabilities and their challenges. They will use this understanding to help them through technology.

Critical Thinking Skills Reinforced

Through role-playing, the students will realize the limitations on disabled individuals. They will combine their understanding and empathy with their technological knowledge and skills to create a solution to various problems. They will report their solutions both orally and visually. The students will have the opportunity to consider and evaluate solutions for different handicapping situations from all groups. They will also receive input from their classmates on the validity of their solutions.

Teaching Tips

1. Simulate the role-playing situations as accurately as possible.
2. A students may have a strong emotional reaction to this exercise due to past experience. Allow that student to either change his disability or act as an aide to the students who need assistance. Encourage him/her to participate as much as possible. Require him/her to work with a group and turn in all work.
3. Be sensitive to the additional needs of all your disabled groups. You may need to offer suggestions on ways for them to communicate in their groups. Don't offer suggestions too quickly. The only way they will develop an understanding of the limitations is if they experience the frustrations.
4. Emphasize strongly how technology can help these people become more independent. Stress that as your goal. Encourage them to use robotics and computer technology in their solutions. The school librarian would be an excellent resource for information on current technological innovations to stimulate your students' imaginations.
5. A physical therapy clinic, a hospital, or a medical supply store may be willing to bring some new and old devices to show your students.
6. When you begin the reporting and evaluation process, be sure all the students have notebook paper to write their reactions and suggestions to share with the groups individually. You may want to give only a "credit" or "no credit" grade for this part of the exercise.
7. An excellent follow-up activity to this one is "Homes Adapted for Handicapped Living."

Instructional Strategy

- Open the class by setting up an environment for your students to simulate disabilities.
- Monitor the students during their brainstorming exercise and offer any assistance they may need in stimulating their imaginations to identify limitations.
- Organize the groups for the evaluation process.
- Evaluate the students according to their creativity in design and accuracy of reporting.

Equipment/Supplies

1. Disability Challenge Sheet
2. Disability Assistance Sheet
3. Materials to simulate disabilities—blindfolds, plastic wrap to simulate partial sight, earplugs, long strips of fabric to secure arms or feet
4. Paper and pencils for sketching and evaluating

Evaluation Key

Student will be graded on the Disability Challenge Sheet that they turn in individually and the Disability Challenge Sheet from their group. They will also be graded on the Disability Assistance Sheet and the five drawings that describe the device. They will receive "credit," or "no credit," for the evaluation and suggestions for the other groups.

Support Materials

1. Current technological magazines and journals
2. Current textbooks

Name ______________________________

Disability Challenge Sheet

My disability is __________________. _____ Individual _____ Group Report

What is it that you want to do or need to do, but cannot?

What are the obstacles that keep you from completing the task? Give details.

1. ____

____

____

2. ____

____

____

3. ____

____

____

4. ____

____

____

5. ____

____

____

6. ____

____

____

7. ____

____

____

8. ______________________________

____

____

9. ______________________________

____

____

10. ______________________________

____

____

Name ______________________________

Disability Assistance Sheet

Study the task and the limitations on the *Disability Challenge Sheet*. What technological device could be created to assist in the job? Consider the use of robots and computers. Be creative.

1. ______________________________

____

____

2. ______________________________

____

____

3. ______________________________

____

____

4. ______________________________

____

____

5. ______________________________

____

____

Include drawings for all solutions.

Handicap Choice Cards
Make as many copies as you need.

Partially Sighted	**Partially Sighted**
Visually Impaired	**Visually Impaired**
Hearing-Impaired	**Hearing-Impaired**
Speech-Impaired	**Speech-Impaired**
Mobility-Impaired	**Mobility-Impaired**
Unable to use hands	**Unable to use hands**

DESIGNING DEVICES TO HELP PEOPLE WITH DISABILITIES

Role-play a disability to realize the limitations and challenges faced, then design devices to help complete ordinary tasks.

Challenge Statement

You've had a terrible accident. Things that were so easy for you before are nearly impossible now—simple things like eating, brushing your teeth, talking on the phone, or going shopping. Now you must rely on others for help and on the advances made in technology that will replace some of the functions that you took for granted.

Objectives

- To experience the feelings of frustration from having a disability
- To develop an understanding of the limitations and challenges facing those with disabilities
- To use your understanding to develop technological devices to help with simple tasks

Vocabulary

- Hearing-impaired
- Paralysis
- Restricted motion
- Speech-impaired

Equipment/Supplies

- Disability Challenge Sheet
- Disability Assistance Sheet
- Materials to simulate disabilities—blindfolds, plastic wrap to simulate partial sight, earplugs, long strips of fabric to secure arms or feet
- Paper and pencils for sketching and evaluating

Introduction

There are thousands of people in the world with disabilities; some were born with them, while others experienced an illness or accident. Whatever the cause, people must learn to accomplish simple tasks in adaptive ways. For instance, we can go to the grocery store and choose what we want, put it in a basket, pay, drive home, and store the groceries in the cabinets. For someone without vision or motor abilities, this becomes a very difficult task.

Fortunately, people help people. Yet sometimes help is not available, and there are tasks that people with disabilities want to do for themselves that provide independence from others. It becomes the job of designers, engineers, and manufacturers to create devices, using modern technology, that will allow people with special needs to accomplish their goals.

With the advent of robots and computers, more avenues are open to designers to develop devices to assist individuals with disabilities.

Procedure

1. Draw a disability card out of the box. Just like in the real world, we are sometimes given challenges we need to learn to handle. For the next two or three class periods, you will role-play your disability to develop an understanding of special needs. Follow the directions to help you simulate your particular challenge:
   a. *Visually impaired:* Tie a blindfold around your eyes.
   b. *Partially sighted:* Wrap two layers of plastic wrap around your eyes.
   c. *Hearing-impaired:* Use earplugs *and* the ear protectors from the lab, if available.
   d. *Speech-impaired:* Tie a cloth around your mouth to remind you not to speak.
   e. *Mobility-impaired:* Tie a cloth around your feet and knees to remind you not to walk.
   f. *Unable to use hands:* Tie your arms to your body with a cloth to remind you not to use your hands or arms.
2. Simulate your disability now.
3. Return to your regular seat, and listen to the instructions from your teacher, then get into a group with your classmates with the same challenge. You may need help moving into groups. In your groups, brainstorm the problems you think people with your disability have.
4. Now work independently. Imagine yourself waking up in the morning to start the day. Go through your normal routine in your mind. What tasks are you unable to do? Record your obstacles on the Disability Challenge Sheet.
5. Review the Disability Challenge Sheet with your group. Did you have similar challenges? Choose ten of the greatest and most common challenges your group had. Record the group challenges on one Disability Challenge Sheet. You will each turn in your sheet, and your group will turn in one common sheet.
6. As a group, choose five of the challenges that you would like to design solutions for from the Disability Challenge Sheet, and brainstorm possible solutions. Brainstorm one challenge at a time, and record the final idea for a device on the Disability Assistance Sheet. Include a drawing of the device with each idea that includes the basic size of the device and the materials used to produce it. When this part of the project is complete, you will turn in a Disability Assistance Sheet and five drawings labeled with a name for the device. If you have the appropriate computer software, design your device on the computer.
7. Come together as a class, and present your creative devices. Give the class the reasons for their need, and justify the solution.
8. On a sheet of notebook paper, write your impressions of the ideas the other groups present. Make any suggestions you may have to add to or adapt their product. Your instructor will share this information after all the presentations have been made.

Evaluation

You will be graded on the Disability Challenge Sheet that you turn in individually and the Disability Challenge Sheet from your group. You will also be graded on the Disability Assistance Sheet and the five drawings that describe the device. You will receive "credit," or "no credit," for the evaluation and suggestions for the other groups.

PACKAGING FOR TODAY'S SOCIETY

Essential Elements: 75.50 (b): 2C, 2D, 3A, 4A, 4B, 5B, 6A-E, 7A, 8A, 8B
75.50 (f): 1, 2, 4, 6, 7, 14, 17
75.50 (g): 1A, 1B, 1F
TAAS Objectives: Language Arts: RC 1-6, WC 1-4
Mathematics: C 1-2; O 1-4

Activity Overview
Your students will brainstorm and study consumer and industrial concerns about packaging of manufactured products, and they will redesign an existing product package.

Challenge Statement
Durable, stackable, attractive, cost-efficient, informative, protective, and ecologically sound. These are all desirable characteristics of packaging for consumer goods. Think of the thousands of products that are shipped, and you begin to understand one of the hidden problems of packaging—garbage. How do manufacturers meet positive characteristics of packaging and overcome negatives?

Through this activity, the students will understand the importance of effective and responsible packaging. They will have the opportunity to redesign a package to help them apply packaging considerations.

Systems Model
Resources
Students as industrial designers and evaluators
Instructor as resource person and evaluator
Packages for evaluation
Materials to design and construct new packages
CADD if available

Processes
Reading and studying new information
Analyzing existing packages
Designing new packages
Evaluating and prioritizing new designs

Applications
Creative problem solving in a real-life situation
Sketching and design skills to a design problem
Marketing and distribution knowledge to packaging

Impact
Industry's responsibility to society
Career opportunities

Interfacing with Other Disciplines

Language Arts:	Students will learn new words and concepts. They will understand the impact of the written word on consumerism.
Mathematics:	Students will use measurement to design and construct their packages.
Science:	Students will understand the importance of using the proper materials in packaging. They will understand the importance of recycling.
Social Studies:	Students will realize the importance of using recyclable packaging materials. They will understand how consumer concerns affect industry.

Teaching Tips

1. Look through technical magazines and journals to find articles on current trends in packing materials, such as the cornstarch packing chips. If you would like to demonstrate them to your class, call a local Amway distributor. Amway ships their products with these chips.
2. Amway won an award from the United Nations for their work in the environment and will send information to your students by calling 1-616-676-7196.
3. You will need to have a large number of packages on hand for the first day of this activity. Food containers are familiar to students and will be easy to collect. Some of the other teachers may be willing to help.
4. Some students may forget to bring containers to redesign. You can take off points if they use your packages, or you can reward those who remember with extra points.
5. Display the favorite packages in a school display case, if possible. The art and language arts classes may want to conduct an integrated unit with your class and be included in the display.
6. The language arts students can design advertising around the new product designs. The art classes can produce professional renderings for the packages from the sketches your students produce.

Instructional Strategy

- Open the class by showing examples of packaging.
- Help students expand their understanding of the role packaging plays in marketing and distributing products.
- Monitor the students as they construct models of redesigned packages.
- Close the activity with an evaluation of the designs.

Equipment/Supplies

1. Various packages for review
2. Posterboard
3. Markers
4. Map pencils
5. White and colored paper
6. Tape or glue
7. Staples

Evaluation Key

Set the standards for package design according to the level of your class and the equipment available (CADD/CAM).

Support Materials

1. "Design Brief—Packaging: More Than Just a Box!" *The Technology Teacher*, January 1991.
2. Sias, Jim. "Packaging for Posterity—Environmentally Responsible Packaging Design." *Drexel University TIES,* September/October 1990.

Modifications for Handicapped, Disadvantaged, and LEP Students

Some students may need additional time or help with manipulation of tools and materials.

Packaging Review

#1 What product was this package designed to contain? ____________________

Describe the (A) age range, (B) gender (male or female), and the (C) activity level of the audience. (A) __________ (B) __________ (C) ____________________

____

Do you think the colors and design would attract this audience? ______ Why? __________

____

____

What information is given about the product? ____________________

____

What materials are used in making the package? ____________________

Why do you think they chose those materials? ____________________

____

Is the package durable? __________ Can it be easily stacked? __________

Is it recyclable? ______ What did the manufacturer do to make the product environmentally sound? ____________________

____

# 2 What product was this package designed to contain? ____________________

Describe the (A) age range, (B) gender (male or female), and the (C) activity level of the audience. (A) __________ (B) __________ (C) ____________________

____

Do you think the colors and design would attract this audience? ______ Why? __________

____

____

What information is given about the product? ______________________________________

____

What materials are used in making the package? ________________________________

Why do you think they chose those materials? __________________________________

____

Is the package durable? _________ Can it be easily stacked? ____________________

Is it recyclable? _________ What did the manufacturer do to make the product environmentally sound? ____

____

PACKAGING FOR TODAY'S SOCIETY

Brainstorm and study consumer and industrial concerns about packaging of manufactured products, and redesign an existing product package.

Challenge Statement

Durable, stackable, attractive, cost-efficient, informative, protective, and ecologically sound. These are all desirable characteristics of packaging for consumer goods. Think of the thousands of products that are shipped, and you begin to understand one of the hidden problems of packaging—garbage. How do manufacturers meet all the positive characteristics of packaging and overcome negatives?

Objectives

- To develop an understanding of the volume of garbage generated through packaging
- To understand all the characteristics industrial designers consider in designing packaging
- To redesign a package for a familiar product

Vocabulary/Concepts Introduced

- Logo
- Graphics
- Nutrition information
- Consumer information
- Recyclable

Equipment/Supplies

- Various packages for review
- Posterboard
- Markers
- Map pencils
- White and colored paper
- Tape or glue
- Staples

Introduction

Industry spends a lot of time and money packaging their products. These packages are important to market and distribute their products, not just hold the goods. Industrial designers consider many factors when designing their containers:

- Presenting the information on the package in an attractive and appealing way
- Protecting the product
- Keeping the cost of printing, materials, and construction down
- Making a package that is easy to stack and store
- Using materials that are durable to ship
- Regulating the volume and type of garbage generated

With the hundreds of products on the market, designers have a challenge in choosing colors and designs that attract consumers. Competition has become fierce for the consumer dollar, and an attractive, informative package will sell the product to a customer who is not already product loyal. This kind of spontaneous purchase is important to industry. The package on the shelf ends up being the salesperson. Once the buyer takes the package home, the quality of the product must prove itself. If the customer never takes it home, he or she will never try it.

The main consumer must be taken into consideration when you think of the package as advertising. If you are packaging a toy for a three-year-old, you wouldn't put the picture of a teenager watching TV on the package. That is common sense. The age group and "audience" of the potential buyer is always considered in the design of the package.

From a technical point of view, the industry needs to approach packaging from a practical perspective. They can design an outrageous package that would attract everyone in the store, but could they afford to make it for every product? Would it be easy to handle and store? And would it be durable and practical to ship? All of these things must be taken into consideration.

Protecting the product is the most critical feature of packaging. Styrofoam was an important discovery for protecting products during shipping. It is lightweight and can be shaped to fit the product. Unfortunately, whereas Styrofoam met one need, it created another; garbage. Many companies are using a new packing chip that has the advantages of Styrofoam, but is made of cornstarch and dissolves within seconds with water.

Years ago waste production was not a concern in packaging. However, because the number of landfills available has declined from 14,000 in 1978 to 5,500 today, with an estimated 1,500 by the year 2000, the focus is changing. People are more concerned about the impact of packaging on society, and industry is pressed to take it into account.

Two areas that industry focuses on to reduce waste in landfills are concentration of product and recyclability of packaging materials. For years Americans have had the philosophy of "more is better." Now with concern over waste materials, concentrated consumable products are becoming more popular and marketable. Fillers and water are being taken out of cleaning products and being packaged in smaller containers. Recycled and recyclable materials are being used in packaging materials.

When you go to the store, you take packaging for granted. You are unaware of the time, consideration, and money that go into packaging. When you study different packages and design one of your own, you will appreciate all the effort that is involved.

Procedure

1. Read and review the preceding information. Brainstorm industries' considerations for packaging.
2. Choose two packages to analyze, and fill out the Packaging Review sheet. Discuss the review sheets with the class.
3. Think of all the products you use everyday, such as cereal, toothpaste, soap, deodorant, milk, frozen food, canned goods. Bring a package of a product you use to class to redesign.
4. Taking all packaging concerns of industry into account, sketch a new design for the product you brought to class. If CADD/CAM is available, use it.

5. Construct your package. You can use the existing package as a base and tape or glue your design to it, or construct a whole new package. Review your design according to the questions on the Packaging Review sheet.
6. Review and analyze all the new packages, using the questions on the Packaging Review sheet.
7. Take a class vote to determine the favorite packages to display to other students.

Evaluation

You will be graded on your participation and cooperation in the class and the accuracy of your Packaging Review sheet. Your major grade will come from the package you design. Your teacher will give you the standards for construction.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 33
(2-3 WEEKS)

WHAT'S NEW WITH ROBOTS?

Essential Elements: 75.50(b): 2C, 2D, 4A, 4B, 5A, 6A, 6B, 6D, 7A, 7B, 8A, 8B
75.50(f): 1, 2, 6, 14, 18
75.50(g): 1A, 1C-G, 2G, 2H
TAAS Objectives: Language Arts: RC1-6; WC 1-4
Mathematics: C 1, 3, 4; O 1, 2; PS 2

Activity Overview

This activity has three parts: (1) Your students will learn more about robots to give them a basis to determine if robots would be practical in homes, schools, and offices. (2) They will design robots that could be useful in the home, office, or industry. (3) They will make a simple robot.

Challenge Statement

Many tasks at home or in the office are really menial and repetitive. It's a wonder that no one has designed simple robots to complete these tasks for busy people. Robots have been incorporated into industry to replace people in jobs that are repetitive or dangerous.

Because of the types of tasks we have in our homes, schools, and business offices, robots may or may not be useful. What do you think? What would you like a robot to do for you besides your school work! ? Would your calculator be a kind of thinking robot?

This activity is designed to give your students a foundation of information about robots to work from, to help them determine the practicality of robots for common use. They will also be able to design and build a robot to enhance and apply the information.

Systems Model

Resources

Reference materials
Robot information sheet
Students as researchers, designers, and builders
Instructor as resource person, monitor, and evaluator
Tools and materials necessary to design and build a robot

Processes

Researching the assigned topic on robots
Compiling information on robots
Reporting information from topic areas
Cooperative teaching and learning
Designing a robot
Constructing a robot
Evaluating the usefulness of robots for common uses
Evaluating robot designs

Applications

Research compiling, and reporting skills, to the robot report
Extension of information to the imagination and design of a robot
Tool skills to the construction of a robot

Impact
Student career choices
Using the imagination as a problem solver
The use of robots at home, school, or the office

Interfacing with Other Disciplines

Language Arts:	Students will do research, write a report, and give an oral report to the class. They will also listen to reports and record information.
Mathematics:	Students will use drawings to express the solution to a problem.
Social Studies:	Students will study the history of robots and their impact on society.

Critical Thinking Skills Reinforced

The students will research various topics on robots to gain insight into the value of robotics to society. They will analyze information about the uses of robots in industry and transfer their deductions to the uses of robots in homes, schools, and offices. They will then have the opportunity to devise a simple robot to demonstrate their understanding.

Teaching Tips

1. Reserve a day at the library with your school librarian. Give her/him your topic in advance so she/he can have references ready for your students.
2. During the reporting phase, give the students time to fill out their Robot Information Sheet. You may need to review to help them complete their sheets.
3. You will determine the standards for your students' drawings, as well as the amount of detail required, depending on the time, equipment, and experience available.
4. This activity does not specify the tools, materials, or instructions for your class to build their robots. Each class will vary depending on the expectations of the instructor and knowledge and skill of the students. Many of the new textbooks have activities outlining the construction of a simple robot. Your school librarian can help you find plans from the school's reference materials.
5. Evaluate the practicality of robots for common use according to cost and usefulness. The students will have different opinions that will lead to an interesting discussion. You may want to record the advantages and disadvantages on the board.
6. If you have the space, set up a display with drawings and descriptions either in the classroom or in the school.

Instructional Strategy

- Open the activity by assigning the topics the students will cooperatively teach.
- Allow adequate time for the students to research and compile information.
- During the reporting phase, help the students transfer and relate the information to the uses of robots in homes, schools, and offices.
- Encourage reluctant students to provide input from their reports.
- Close the class by stressing the important impact and uses of robots both now and in the future.

Equipment/Supplies

1. Reference materials from the library
2. Standard drafting tools and materials
3. Materials and tools to construct a robot

Evaluation Key

You will grade your students on—

1. the report from their topic area;
2. the Robot Information Sheet;
3. the drawing and written description of their robot; and
4. the quality of workmanship and accuracy of the robot.

Robot Information Sheet Answer Key

1. "Robot" is derived from the Czech word *robit*, meaning work.
2. The first robot came from a play, ***Rossum's Universal Robots***, written by the Czechoslovakian writer, Karel Capek.
3. Robots are machines. Machines are apparatuses designed to accomplish a task. The robot is simply an advanced machine.
4. Robots are used in industry: (1) for welding, (2) for spray painting, (3) for drilling, (4) for pick and place operations. (Any three)
5. Advantages:
   a. Robots repeat tasks continually with consistent results; they do not tire.
   b. Robots do not need sick leave and medical insurance.
   c. Robots do not receive vacation time.
   d. Robots can work 24 hours a day.
   e. There are no parking problems for robots.
   f. Robots do not need benefits or a paycheck.
   g. Robots do not go on strike.
   h. Robots can work in dangerous conditions, such as high temperatures, darkness, or outer space.
   i. Robots produce a high degree of consistent accuracy.
6. Limitations:
   a. Robots cannot problem-solve.
   b. Robots can perform only a limited number of functions.
   c. Robots do not think.
7. Degree of freedom relates to the movement of the robot arm: arm sweep, shoulder swivel, elbow extension, wrist pitch, wrist yaw, and wrist roll.
8. Mechanical robots perform simple functions much like an ordinary machine. Industrial robots are computer-operated and perform more complex tasks with a high degree of accuracy.
9. An anthropomorphic robot duplicates the complete human arm motion. It is the most complex of all the robots.
10. The robotics sensor acts as the human senses of sight, touch, and hearing. They involve pressure sensors, light sensors, and video cameras.

Support Materials

1. Any current textbook
2. Encyclopedias

Name ______________________

Robot Information Sheet

1. Where does the term *robot* come from? ______________________

____

2. Who made the first robot?______________________

3. How are robots and machines related? ______________________

____

____

____

____

4. Identify three ways robots are used in industry. ______________________

   a.______________________

   b.______________________

   c.______________________

5. What are three advantages robots have over humans on a production lines in industry?

   a.______________________

   b.______________________

   c.______________________

6. What are two limitations of robots? ______________________

   a.______________________

   b.______________________

7. What does degree of freedom mean in relation to robots?______________________

____

____

8. What is the difference between a mechanical robot and an industrial robot? ______________________

____

____

9. What is an anthropomorphic robot? ______________________________

____

____

10. What is the role of a robotics sensor? ______________________________

____

____

____

WHAT'S NEW WITH ROBOTS?

Learn more about robots to determine if they would be practical in homes, schools, and offices; design robots that could be useful in the home, office, or industry; and make a simple robot.

Challenge Statement

Many tasks at home or in the office are really menial and repetitive. It's a wonder that no one has designed simple robots to complete these tasks for busy people. Robots have been incorporated into industry to replace people in jobs that are repetitive or dangerous.

Because of the types of tasks we have in our homes, schools, and business offices, robots may or may not be useful. What do you think? What would you like a robot to do for you—besides your school work! ? Is your calculator a kind of thinking robot?

Objectives

- To learn about the history of robots
- To learn more about the advantages of robots in industry
- To understand the many uses of robots in industry
- To transfer the many uses of robots in industry to determining their usefulness in homes, schools, and offices
- To design robots of the future

Vocabulary/Concepts Reinforced

- Actuators
- Anthropomorphic robot
- Arm sweep
- Control mechanisms
- Degree of freedom
- Degree of repeatability
- Drives
- Elbow extension
- Industrial robot
- Mechanical robot
- Pick and place operations
- Range of motion
- Sensors
- Shoulder swivel
- Work envelop
- Wrist pitch
- Wrist roll
- Wrist yaw

Equipment/Supplies

Reference materials from the library
Standard drafting tools and materials
Materials and tools to construct a robot

Introduction

We've all heard of robots. We may have seen one or had one as a toy, but we do not really have them available to us for everyday use. Industry uses them to a great extent in production lines to replace workers in dangerous situations or where repetitive work is necessary or where a high degree of accuracy is required.

Many of the products we use in our homes were designed for use in the military or in industry. The radio, TV, computers, and the microwave oven are all examples of such products. The robot could be another! The history of machines and robots is the foundation for future developments in robotics.

Procedure

1. For the next two days you will do research in one of three areas. Your teacher will either assign your area or let you choose one. The areas are:
    a. Research the history of robotics.
        (1) Where did the term *robot* come from?
        (2) Who is responsible for the idea or the first robot?
        (3) How were robots originally used?
        (4) Did machines influence the invention of robots?
        b. Research the use of robots in industry.
        (1) What are the uses of robots in industry?
        (2) What advantages do robots have over humans in industry?
        (3) What are the limitations of robots in industry?
        (4) What future role is projected for robots in industry?
    c. Research the design of simple robots. Your work will be in the form of sketches or drawings.
        (1) Draw a simple robot, according to the standards your teacher outlines, demonstrating the different degrees of freedom.
        (2) Label each drawing to describe the function.

    Research your topic carefully and accurately as you will share the information with the rest of the class. You can either volunteer, or you may be called on to share your work. You will turn this report in to your teacher for a grade. Do it well. In business your work is worth money.
2. Listen carefully as some of the students report the information from their topics. Complete the Robot Information Sheet as you listen to the reports. You will receive a grade for this paper too. Listen well.
3. a. Use the information you learned from the reports to design a robot for use either at home, at school, or in the office. Think of all the jobs that need to be done. What do your parents do at home to keep it running? What do your teachers do at school?
    b. Draw the robot according to your teacher's standards. If you have the software, use the computer for your drawings.
    c. On a separate sheet of paper, give this information about your robot. (1) What is it called? (2) What task does it perform? (3) How does it save you work? (4) Considering what it would cost and the size, would it be practical for use in a home, school or office. (5) What need does it fill? (6) How would you encourage someone else to buy one?
4. Share your idea and design with the class, and review their suggestions.
5. Build a simple robot using the materials and tools your teacher provides. Your teacher will outline the standards for your work.

Evaluation

You will be graded on—

1. the report from your topic area;
2. the Robot Information Sheet;
3. the drawing and description of your robot; and
4. the quality of workmanship of the robot you build and on how well you met the standards for construction.

INTRODUCTORY INDUSTRIAL TECHNOLOGY I
INSTRUCTOR'S RESOURCE SHEET 34
(3 WEEKS)

WHOSE TURN IS IT TO TAKE OUT THE GARBAGE?

Essential Elements: 75.50(b): 1A, 1B, 2A, 2C, 2D, 3A, 3B, 4A, 4B, 5A, 5B, 6A-E, 7A, 7B, 8A, 8B
75.50(f): 1, 2, 4, 6, 7, 13, 14, 17
TAAS Objectives: Language Arts: RC 1-6; WC 1-4
Mathematics: C 1-4, O 1-4, PS 1-4

Activity Overview
Students will research the importance and impact of recycling and set up a recycling center at school.

Challenge Statement
In 1978, there were 14,000 landfills available in the United States. Today there are about 5,500 landfills in operation, with an estimated 1,500 available by the year 2000. *What are we going to do with all our garbage?*

This is a critical issue for you and your students. Waste disposal becomes more serious each year. Teaching your students to be involved in a recycling campaign now will help them be more responsible as adults. Becoming aware of the problem may trigger solutions and opportunities for some of them.

Systems Model
Resources
Students as researchers, planners, designers, and marketing and public relations specialists
Teacher as resource person, organizer, and monitor
Materials necessary to design and build recycling collection containers

Processes
Research recyclable materials
Brainstorm recyclable materials at school
Contact local agencies, businesses, and schools about recycling
Plan a schoolwide recycling campaign
Design and construct recycling receptacles
Implement an ongoing, schoolwide recycling campaign
Teamwork

Applications
Research skills to recycling
Planning skills to recycling
Math skills to design
Design to recycling
Social awareness to recycling

Impact
Career awareness
Social responsibility
Environmental awareness
Present and future recycling programs

Interfacing with Other Disciplines

Language Arts:	Students will learn the meaning of new words and concepts. They will write a short report on recyclable materials, and formulate a schoolwide recycling program.
Mathematics:	Students will design and build recycling containers. This will involve dimensions, measuring, and estimations. They will see the issue stated in numerical terms.
Science:	Students will study recycling as it affects our environment.
Social Studies:	Students will understand the responsibility of each individual to recycle.

Critical Thinking Skills Reinforced

Students will assess the garbage at their school and develop a recycling program. They will construct collection receptacles and place them strategically throughout the school. They will formulate a program to inform the school population about the need to recycle, and organize collection procedures.

Teaching Tips

1. Before the unit begins, you will need to clear the program with the administration. The math and science classes could get involved as they have EEs in their areas about recycling. The more areas that get involved, the more successful your program will be. You can find an integrated unit on recycling in the UT-EIMC publication, *Applied General Education Through Technology Education*, 1992.
2. The students can conduct their meetings according to parliamentary procedure. Have each committee elect one representative who will act as an officer. From the four representatives, the class can choose a president, vice-president, secretary, and treasurer.
3. If you have more than one class involved, divide the school into zones, and assign a zone to each class.
4. Involve as many parents and outside sources as possible. You may need to bring the materials to recycling centers. It would be helpful to solicit a parent volunteer, with a truck, each month. If you have several parents, this will not be too great a time commitment.
5. If you receive money for the materials, you can organize a beach cleanup or road cleanup field trip. Involve the science department as much as possible.
6. The success of this program rests on you. Your enthusiasm, consistency, and persistence will be necessary for the program to succeed.

Instructional Strategy

- Open the class with a lecture and discussion from the Introduction.
- Provide students with adequate reference materials and current events to complete their resource paper.
- Monitor the students in their groups.
- Organize the materials needed to construct collection bins and implement the campaign.
- Assess the program regularly to ensure its success throughout the year.

Evaluation Key

Students will be graded on the quality of their research, the design of the collection devices, and the overall organization of the program.

Support Materials

1. "Plastic Bottles in Our Environment," information teaching kit available from The Plastic Bottle Institute, 355 Lexington Ave., New York, NY 10017, (212) 573-9400.
2. Environmental Defense Fund, 1616 P Street, N.W., Washington, DC 20077-6048
3. National Center for Resource Recovery (PBI), 1211 Connecticut Ave., N.W., Washington, DC 20036
4. O'Keefe, C.A.M. *Applied General Education Through Technology Education.* Austin: EIMC, The University of Texas at Austin, 1992.
5. Chevan, H. "Recycling Returns," *Office Systems*, April, 1992.

Modifications for Handicapped, Disadvantaged, and LEP Students

Special students may need additional time to complete the research paper. No other modifications are necessary.

WHOSE TURN IS IT TO TAKE OUT THE GARBAGE?

Research the importance and impact of recycling and set up a recycling center at school.

Challenge Statement

In 1978 there were 14,000 landfills available in the United States. Today there are about 5,500 landfills in operation, with an estimated 1,500 available by the year 2000. What are we going to do with all our garbage?

Objectives

- To understand the importance of recycling our environment
- To begin to understand the volume of recyclable garbage generated in schools and offices
- To learn which organizations are recycling in your area
- To contribute toward recycling efforts in your school and community

Vocabulary/Concepts Reinforced

- Bias
- Biodegradable
- Environment
- Expected outcomes
- Long-term
- Nonrecyclable
- Photodegradable
- Recycling
- Returns
- Short-term
- Unexpected outcomes

Equipment/Supplies

Appropriate materials and equipment to build students' recycling aids

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Introduction

This information comes from the Environmental Defense Fund.

- Every Sunday more than 500,000 trees are used to produce the 88 percent of *newspapers* that are never recycled.
- We throw away enough *glass* bottles and jars to fill the 1,350-foot Twin Towers of New York's World Trade Center every two weeks.
- American consumers and industry throw away enough *aluminum* to rebuild our entire commercial airfleet every three months.
- We throw away enough *iron and steel* to continuously supply all the nation's automakers.
- We throw away enough *office and writing paper* annually to build a wall 12 feet high, stretching from Los Angeles to New York City.

There is a lot of waste in our garbage! Add this to the diminishing landfill situation, and recycling comes out as the answer to two waste problems.

Recycling is not new in our country, but it is often overlooked. More than 30 million tons of paper, iron, steel, aluminum, and glass were recycled in 1991, but millions of tons were put into the landfills. During World War II, recycling drives provided scrap metal and rubber for the war effort. We are not in a world war, but we are now in a waste war against the growing volume of garbage.

In an article titled, "Someone Left a Mess in Texas," in the *Austin American-Statesman*, Bob Banta reported that nearly 400,000 pounds of debris was collected from 169 miles of beach along Texas beaches in September 1991. Linda Maraniss, head of the Center for Marine Conservation's Austin office, said that over 73 percent of the debris collected by volunteers was plastic bottles, lids, and cups. Of the remaining debris, metal comprised 8.14 percent, glass 7.58 percent, paper 5.43 percent, rubber 2.21 percent, wood 2.11 percent, and cloth 1.04 percent.

Each and every one of us produces garbage, so it is our responsibility to dispose of our garbage in an accountable way. There are currently federal and state laws governing recycling, but the main focus is on voluntary programs in cities, homes, offices, and schools.

The first step in setting up a recycling program is to get someone to run it. The next step is to gather information about available resources in your community for recycling, and determine the type of waste you have that is recyclable.

Procedure

1. Choose one sentence from the Environmental Defense Fund information as a topic sentence for research. You must report (1) the existing recycling programs for that material, (2) the uses of the recycled materials, (3) problems with recycling that particular material, (4) possible recycling solutions, and (5) industries' responsibility for recycling in regard to the specific materials they produce. Share information from your research with the class. Turn in your written report.
2. Brainstorm the types of garbage that are produced at school. What is the biggest waste? What is second? Itemize the garbage. Don't forget the cafeteria and office. From your class list of garbage, determine what can be recycled. Is any of the garbage nonrecyclable? Biodegradable? Photodegradable? How can you tell? Where is the greatest volume of recyclable garbage generated?
3. Plan and organize a schoolwide, recycling campaign. Determine which materials you will collect and recycle. Do you want a long-term or short-term program? Your teacher will divide the class into four groups. Each group will have a job to complete to set up the recycling program.

   Group 1: Public relations committee (2 or 3 students). (1) You will identify recycling agencies in the area that can be used as a resource for the program. (2) Call or write agencies requesting information about programs set up for homes, schools, and offices. (3) You will call business that buy recyclable materials. Will they pick up your materials, or do you have to deliver them? How much do they pay per pound? (4) Contact other schools in the area about any recycling efforts they have organized.

   Group 2: Planning committee (3 students). You will study a map of the school and determine the best locations for collection receptacles depending on materials being collected. (1) What is being collected? Where is it being generated? Do boxes for paper collection need to be in every classroom? (2) What type of receptacles are needed? (3) How many receptacles are needed for each material? (4) Using symbols, locate collection stations on the map. (5) Determine a pickup schedule for each location.

   Group 3: Design committee (as many students as possible). You will design and draw collection devices for recyclable materials. If a CADD system is available, use it. Plan a Bill of Materials for each receptacle. You may use existing containers. The container must be compact, attractive, lightweight, and easy to empty.

Group 4: Finance committee (2 or 3 students) You will design a handbill to give or mail to businesses, organizations, and individuals about your campaign plans, requesting funds or materials.

4. Each group will report their progress to the class.
5. Form two groups. One small group will design an educational campaign to inform teachers and students about the recycling program. This can involve posters and school announcements. The second group will build the containers.
6. Implement the program by—
   1. placing collection containers in designated areas;
   2. informing students, teachers, and staff about the receptacles and the need for the program; and
   3. assigning a collection schedule for the year.
7. Discuss personal recycling responsibility. What can you do at home to help recycling? Would talking to your friends and family about recycling statistics help? Do you have a community campaign? Do you participate?
8. Discuss the impact of diminishing landfills on business. Will there be more career opportunities in garbage disposal in the future? Is there a need for technological innovations in garbage collection and disposal?

Evaluation

You will be graded on the quality of your research, the design of the collection devices, and the overall organization of the program.

CAMPUS CLEANUP

Essential Elements: 75.50(b): 1A, 2C, 4A, 4B, 6C, 6D, 8B
TAAS Objectives: Language Arts: RC 1-6; WC 1-6

Activity Overview

Industrial technology students organize a schoolwide cleanup day in which they collect, categorize, dispose of, and discuss the types of trash that have been discarded.

Challenge Statement

Waste disposal is one of the most important environmental issues facing industry and technology as we move into the 1990s. Waste disposal will affect everyone in the chain of merchandising from product packaging to consumer disposal of waste material. It includes everything from used motor oil to gum wrappers.

Systems Model

Resources
Students as planners, organizers, and managers
Teacher as resource person, and monitor
Receptacles appropriate for collection, separation, and storage of recyclable materials

Processes
Litter collection
Categorizing and analyzing litter
Displaying and describing litter for schoolwide awareness

Applications
Environmental awareness to schoolwide recycling programs
Teamwork and group skills to class project

Impact
Environmental concerns and awareness

Interfacing with Other Disciplines

This activity supports both science and social studies concepts as they relate to waste disposal and the environment. It is suggested that both the science and social studies departments be involved with this activity.

Critical Thinking Skills Reinforced

Students will use application in determining the background of the waste material that has been collected. Students will analyze, differentiate, distinguish, and make predictions related to waste materials found on campus. Synthesis is used to document the waste materials collected and create a local school plan for better handling of these materials. Evaluation is used in assessing the results of the campus cleanup program.

Teaching Tips

1. If possible, involve both the science and social studies departments in this schoolwide activity.
2. Create a display where the entire school can view the findings of your campus cleanup. It might even be appropriate to create a display for an open house or some other PTA-type activity.
3. Review as necessary the handling of any harmful objects or materials that may be found on your campus.
4. Use a camcorder to record the event.

Instructional Strategy

- Lecture to present the topic to students.
- Arrange for a guest speaker to talk to your students about waste disposal and landfill conditions in your area.
- Check with your regional service center for audiovisual materials relating to waste disposal or landfill topics.
- Use teamwork concepts as appropriate.
- Use group discussions to help organize the activity.

Equipment/Supplies

1. Plastic trash bags
2. Index cards for labeling materials
3. Markers
4. Poster board

Evaluation Key

As with any activity, grade your students according to their participation and cooperation. Set well-defined requirements for the trash display, and grade them accordingly.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can easily accommodate the needs of special needs students. Handicapped students will find it inviting to get outside the classroom environment. It also provides all student an opportunity to become sensitive to keeping our environment clean.

CAMPUS CLEANUP

Plan and organize a campuswide cleanup, classify the found materials according to several criteria, and make recommendations for improving cleanliness of the campus.

Challenge Statement

Waste disposal and landfill conditions are two of the most important issues facing your generation. Although recycling of materials has begun to have a positive effect on environmental conditions, we are still faced with a waste disposal crisis. Industrial Technology students should be familiar with environmental concepts as they relate to packaging, recycling, and waste disposal.

Objectives

- To describe and discuss the use of landfill operations in their local community
- To categorize materials into recyclable and nonrecyclable types
- To make recommendations to handle different types of waste materials
- To organize a system to recycle materials

Vocabulary/Concepts Reinforced

- *Environmental impact*—generally associated with the negative impact that some material, process, or action has upon the environment. The oil spill in Alaska had a significant environmental impact upon the environment affecting plant, animal, and human life in that particular area.
- *Litter*—refers to the throwing away of trash without regard to proper disposal.
- *Recyclable*—in the context of this activity, recyclable refers to any material such as paper, glass, or aluminum that can be recycled back into material processing for reuse.
- *Waste management*—the process of planning, controlling, and handling the waste materials generated by homes, businesses, and industry.

Equipment/Supplies

- Plastic trash bags
- Index cards for labeling materials
- Markers
- Poster board

Introduction

One of the most important issues facing future generations is the management of waste materials. These materials include every type of waste product from nuclear waste to gum wrappers. Millions of tons of trash are generated each day across our country with much of it being deposited into controlled landfills. Some of these materials like paper, glass, aluminum, and a few others are collected and recycled. Too much of it, however, is simply thrown away in parks, on the sides of roads, and places where it is just convenient to drop it and walk away.

Developing an awareness of this problem is very important for the next generation of citizens to grasp. Within the state of Texas there have been several organized attempts to curb the effects of unlawful waste disposal, mainly in the form of litter. The "Don't Mess with Texas" campaign to stop highway litter has been very successful in slowing down highway littering. The "Adopt a Highway" program established throughout the state has also helped by organizing highway cleanup activities along various sections of highways. Another project that takes place annually is the "Texas Coastal Cleanup" program that helps to clean up the sections of beach along the Gulf Coast. These programs and others have worked well to help curb the negative impact that littering has on the environment.

One way to help us understand the importance of the litter issue is to investigate the trash that is improperly disposed of and determine what can be done to encourage its proper handling. What makes up this trash, anyway? Is the material related to a particular product type? Is the trash the result of product packaging? Could the trash be recycled? What are the potential hazards that it poses? How can this problem be addressed on a local level to have a positive impact on the entire world?

Procedure

1. Begin the activity by discussing how your class should approach this project. It is recommended that you include the science and social studies departments to make this a schoolwide project. Divide the entire group into small teams of three or four students.
2. The next step is to divide the campus into areas to be cleaned and assign groups to each area. Discuss the appropriate method for handling hazardous materials that students might find in your particular area.
3. Each team will sweep their assigned area and pick up as much litter as possible. Additional trash bags are available as needed.
4. When the assigned area has been cleaned, each group is to select pieces of trash that represent different types of litter that each group encountered. Categories will probably vary according to schools but may include the following:
    1. Name:
    2. Primary Product: Recyclable/Nonrecyclable
    3. Product Packaging: Recyclable/Nonrecyclable
    4. Possible Source: (Student, Teacher, Passerby)
5. Student groups will then create a display of the different types of trash that they collected and analyzed. A display should be created in which examples of litter can be shown to the entire school.
6. In a large group discussion of the activity, students should discuss how to help prevent the improper disposal of trash on the school grounds. If appropriate, encourage a recycling program in which the entire school can participate.

Evaluation

You will be evaluated on your cooperation and participation during cleanup activities. Your display will be graded according to your teacher's requirements.

THINKING ABOUT THE FUTURE

Essential Elements:	75.50(b): 2C, 2D, 3A, 3B, 6A, 6B, 6D, 7B, 8A, 8B 75.50(f): 2, 4
TAAS Objectives:	Language Arts: RC 1-6; WC 1-7

Activity Overview

Students work independently to think up a technological device that we are likely to see in the future. The device can be a combination of two or more current technologies, such as combining an answering machine with a fax machine. The resulting "voice-fax" machine is expected to be commercially produced by 1996. In this activity, students will "dream up" a new machine and apply marketing information and strategies to it.

Challenge Statement

The concept of "futuring" is an important issue facing students at all levels of education. Combining the theory of futuring with creative thinking skills is an important instructional concept for industrial technology education.

Systems Model

Resources
Students as designers and engineers
Teacher as resource person and moderator
Material necessary to construct models of inventions

Processes
Researching and analyzing existing products
Inventing new products
Describing and evaluating all models

Applications
Creative thinking to inventions
Problem-solving skills to design
Evaluation to redesign

Impact
Student creativity
New product research

Interfacing with Other Disciplines

Language Arts:	Reading research material and writing technical information
Science:	Information on new and emerging scientific information
Social Studies:	Recognizing and discussing technological impacts

Critical Thinking Skills Reinforced

Students will use creative imagining to design their inventions. They will research and analyze existing products to combine tasks into one machine. Students will evaluate each invention for creativity and usefulness.

Teaching Tips

1. Obtain several Sharper Image catalogs to use as reference material.
2. Obtain old copies of *Popular Science* and *Popular Mechanics* magazines to use as reference material.
3. Review any safety requirements for handling machines or tools if they are to be used.
4. Demonstrate low-relief modeling techniques as needed.
5. Provide access to a variety of materials that students can use to constructing a model of their device. Devices don't necessarily have to work, but can be for illustration only.
6. Encourage craftsmanship in the completion of this activity.

Instructional Strategy

- Use a group discussion to present the topic to student.
- Demonstrate an example of the activity to your students.
- Encourage the use of brainstorming and creative thinking.
- Use technical reference material as available.

Equipment/Supplies

1. Drawing paper
2. Pencils
3. Construction paper
4. Magazines
5. Miscellaneous materials as needed

Evaluation Key

Students will be evaluated on their creativity, their presentation, neatness, and accuracy.

Modifications for Handicapped, Disadvantaged, and LEP Students

This activity can be modified as necessary to accommodate special needs students.

THINKING ABOUT THE FUTURE

Complete a "futuring" activity by combining at least two current technologies into one new device, then create a demonstration model to present the device to the class.

Challenge Statement

The concepts of "futuring" coupled with creative thinking are important challenges facing students of technology. These are issues that will help develop the creative imaginations of the future.

Objectives

- To work independently to complete a creative problem-solving activity
- To use elements of modeling to help illustrate a technical concept
- To discuss and describe how two separate technologies might be combined to form a single technological theory or device

Vocabulary/Concepts Reinforced

- Futuring

Equipment/Supplies

- Drawing paper
- Pencils
- Construction paper
- Magazines
- Miscellaneous materials as needed

Introduction

What types of technological devices will we see 20 years from now? Nobody knows for sure what they will be, but creative minds all around the world are thinking of new and better methods for doing tasks that presently take more than one machine. The "Voice-Fax Machine" is one such device being developed by Trout Technologies in Needham, Mass. They have combined both a voice answering machine and a fax machine into one device. Their device will allow the operator to take incoming calls while storing faxed information that can be checked at a later time. It will also allow the operator to call in from another location and transfer faxed messages that are stored in the machine. This device is expected to be available for the commercial market sometime in 1996 at a cost of about $300.

Another interesting device that is already available on a limited basis is the eye-operated computer. This computer, being developed by LC Technologies in Fairfax, Va., is called the Eyegaze. It will allow a person to view a computer keyboard in the monitor of the computer. The computer is able to sense what key the operator is looking at and allow him or her to perform any keyboard command without touching the computer. It is expected to provide handicapped people another avenue for computer access. This computer is expected to be on the commercial market sometime in 1995 at a cost of about $5,000.

What about a recyclable car? BMW has launched an interesting venture in Landshut, Germany, near Munich in which they are in the process of developing materials that can be automatically recycled. BMW engineers are disassembling some 1,500 cars to study what types of materials are presently being used and how these parts are assembled. They are combining the technologies of recycling with design theory to develop their new automobile. Their engineers hope to develop a car that will be totally recyclable when it finally wears out. Mass production of such a car is not expected until about the year 2000 at a cost of about $22,000.

Procedure

1. Your task for this activity is to take at least two separate technologies and combine them into one useful product. For instance, the Troy Built Company has devised the "Shredder/Chipper," a gas-powered machine that works as a yard vacuum to suckup and shred leaves as well as providing a chipper mechanism to chip small branches.
2. Once you have determined what device you would like to propose, you will need to think about several design criterias. They include the following:
    a. Device name
    b. Estimated market (who will use it?)
    c. Estimated cost
    d. How many years to develop?
3. When you have determined what the device will look like, you will need to construct either a three-dimensional or low-relief model to illustrate it. You will present your invention to the class for discussion.

Evaluation

You will be evaluated on creativity, neatness, and accuracy of your model.

Technology Activity Challenges

1

Problem Solving Through Design

Activity Challenge: Students are asked to solve the following problem using structural design techniques.

Across the river from your neighborhood is large town. The closest river crossing is downstream 20 miles. You and others from your neighborhood work in this town, but it is an hour's drive to and from work. You must design a structure to eliminate the need to drive 52 miles to a town that is only one mile away. Students will evaluate given information on river specifics and then design a structure. Students will determine the effect this structure has on environment, property values, and traffic flow.

Resources:	Drawing tools and equipment
Processes:	Structural design
Applications:	Bridges
Impact:	Property values, barriers, transportation traffic flow

2

Comparing and Contrasting Broadcast Frequencies

Activity Challenge: The student will draw a graph indicating the frequencies used by different telecommunications systems. The student will identify and list the reasons for grouping telecommunications frequencies. The student will make a one- to five-minute videotape on the need for space communication to be presented to the class.

Resources:	Radio, television, telephone, video, and satellite equipment
Processes:	Telecommunications
Applications:	Transmitting information
Impact:	Speed of information gathering and dissemination

3

Plat Drawing

Activity Challenge: The student will draw a community plat drawing and construct a small-scale model of residential and commercial buildings in the community. Include directions for roadwork and other civil construction. The students will then discuss what types of contracting businesses are involved in this construction and what the changes can do to the economy, and to living and working conditions.

Resources:	Materials, equipment, energy
Processes:	Construction
Applications:	Shelter, civil structures
Impact:	Improved living standards, improved working conditions, stimulate economy

4

Mass Production

Activity Challenge: The student will mass-produce two small and simple products, plan a quality control system for use on the production line, and determine the cost of producing the two items on the production line.

Students will set up a corporation to do the above specifics, and elect officers to govern operations using standard parliamentary procedure. These officers will control production, hire and dismiss, design, set up, and supervise the production line, etc.

Resources:	Materials, machines, people
Processes:	Manufacturing
Applications:	Mass-produce products
Impact:	Merchandise that is less expensive, higher quality, and more available

5

Model of a Small Town's Transportation System

Activity Challenge: The student will make a model of a small town's transportation system, including cars, trucks, trains, buses, and other mass transportation vehicles, with major highways and streets. The student will make a bar graph relating the number of cars, trucks, and their types, buses, trains, and other transportation vehicles. The student will research example cities and towns and make a circle graph relating the percentage of transportation used for people and goods. The student will research example cities and towns and make a line graph relating the number of roadway traffic flow, accidents, construction projects, and other improvements needed.

Resources:	Graph paper, maps
Processes:	Transportation
Applications:	Movement of people and goods
Impact:	Distribution and flow of people and goods

6

Product Research

Activity Challenge: The student will conduct a product market survey to determine consumer response to selected products. The student will make a bar graph to show consumer preferences. The result of the bar graph should indicate how more desirable merchandise is consumed, causing an expansion in the consumer market.

Resources:	Products, standards, information, resources, market surveyor
Processes:	Product evaluation
Applications:	Determine the marketability of a product and improve product design
Impact:	Consumer knowledge and marketing strategies

7

Estimate the Cost of Producing 500 Business Cards

Activity Challenge: Using appropriate estimating tools, the student will figure the approximate cost of producing 500 business cards. The students should draw a sketch of the card he or she would produce and use the sketch to determine the number of lines needed, etc. The cost of the product should include the amount of ink, paper, and time required to produce the product, as well as a profit margin if the cards are to be sold.

Resources: Estimating tools, examples

Processes: Sketching, estimating

Applications: Estimating product costs

Impact: Consumer knowledge of cost estimating, and costs involved in consumer products

8

Using Software for Problem Solving

Activity Challenge: The student will use a software spreadsheet to record, store, and manipulate a materials inventory. The student will demonstrate how the use of the program reduces time used to take inventory and update inventory data, and explain how this can reduce the cost of an existing product.

Resources: Computer, software, sample materials listing

Processes: Software application and use

Applications: Inventory control

Impact: Consumer goods production control

9 Photographic Advertising Reproduction

Activity Challenge: The student will take photographs of appropriate advertising ideas, and processing the film. The student will use masking techniques to superimpose images from two or more negatives onto one photograph. The student should be sure to mask out any unwanted material in the negatives, be prepared to explain the before and after effects of the process, and explain how it could be used in the advertising industry to mislead consumers.

Resources:	Photographic materials and equipment
Processes:	Photography
Applications:	Advertising, media
Impact:	Public perceptions, deception, etc.

10 Assembly Line Plan

Activity Challenge: The student will design a simple product. The student will plan and draw an assembly line layout plan, and develop a flowchart for materials and processes. The student will research and study labor costs.

Resources:	Drawing tools and equipment
Processes:	Communication
Applications:	Communicate graphically the flow of materials and processes for manufacturing the product designed
Impact:	Improved product design and development

11

Residential Wiring Schematic

Activity Challenge: The student will draw a set of house plans showing the electrical wiring on a scale of 1/2" = 1'. When completed, the student will present the plan to the class, and have it evaluated to determine the convenience of switch and outlet positions, and the rerouting of wire to save costs and supplies and meet safety codes and guidelines

Resources: Drafting tools

Processes: Scaling, designing and drafting

Applications: Residential design and construction

Impact: Ergonomics

12

Building Entrance Designs

Activity Challenge: The student will evaluate the school's entrances, and redesign the building to be barrierfree. The student will research and study guidelines.

Resources: Federal and state guidelines, school building plans and layout, drafting tools and equipment

Processes: Research, architectural drafting and design

Applications: Redesign/remodeling of building entrances

Impact: Barrierfree entrances for the disabled

13

School Campus Landscape Layout and Design

Activity Challenge: The student will study and evaluate the existing landscape design of the school campus (or a portion of the campus). The student will, based upon his or her evaluation, redesign the school's (or portion of the school's) landscape making recommendations.

Resources: Drawing equipment, modeling materials

Processes: Design

Applications: Landscaping

Impact: Environment

14

Research and Design a Methane Gas Collector

Activity Challenge: The student will write a 5-page research paper on methane gas and then design a methane gas collector and produce working drawings. The student should discuss the effects of methane gas collection and use in comparison to the effects of gasoline and diesel fuel concerning conservation and environmental pollution.

Resources: Library, drawing equipment and materials

Processes: Research and design

Applications: Development and use of an alternate energy source for industry

Impact: Reduction in pollution, energy consumption

15 Cartoon Drawing

Activity Challenge: The student will draw a series of cartoons related to the ideal of "safety first." Draw as many cartoons as needed to get your particular safety point across to the general public. One might have a topic like "Safety in the Home" as the theme of the series. After finishing the drawings and coloring the cartoons, students may want to convert the drawings to video and have a videotape on safety.

Resources: Drawing equipment, video equipment

Processes: Drawing, videotaping

Applications: Communicating safety

Impact: Human needs of safety awareness

16 Video Production

Activity Challenge: The student will produce storyboards for an existing television commercial. The student will explain to the rest of class how the storyboard might be used for videotaping and how the tape might educate people or persuade them to make purchases.

Resources: Tape of a commercial, tag board, drawing equipment

Processes: Storyboard design

Applications: Communicating visually

Impact: Commercial advertising and the influence it has on public perceptions

17

Video Role Playing

Activity Challenge: Students will be asked to role play one of the following positions: board of directors, applicant, interviewer, camera operator, etc. Their responsibility is to fill a job opening. The interviewer and applicants are provided a copy of questions that will be asked. The board is provided with a list of qualifications. These groups are given time to review these sheets. Each applicant is interviewed separately as they are filmed. The board reviews the tape and selects an applicant. The students then regroup as a class and watch the tape. The students will list the positive and negative points of each applicant. The students will divide into small groups and discuss the differences between taping interviews and interviewing one-on-one.

Resources: Videotape equipment, scripts, props, application forms, actors

Processes: Videotaping

Applications: Business employment procedures

Impact: Student awareness of interviewing procedures for applying and getting a job

18

Advertising a Product

Activity Challenge: Each student will design a layout to advertise and sell a product. Each student will include photographs and print copy in their design and will assemble photos, ad copy, and print ad. Students will present their ads to the class for discussion and evaluation. Students will discuss whether the general public would purchase their product based on their advertisement.

Resources: Design materials and equipment, photographic equipment, and layout equipment

Processes: Photography, design and drawing, printing

Applications: Communication

Impact: Communicating through the media and the influence it has

19 Newspaper/Video Production

Activity Challenge: Students are divided into several groups. Students will read newspaper articles and then produce a videotape that explains the information in the article. The students must use elements other than just reading the article in front of the camera. Each group will exchange articles and tapes to view, and will review and evaluate each.

Resources:	Videotape equipment, newspaper
Processes:	Videotaping
Applications:	News program, television broadcasting
Impact:	Social awareness through various media

20 Isolation in Space

Activity Challenge: Design and build an isolation chamber to examine problems with prolonged space exploration.

Resources:	Design and drawing tools, modeling materials
Processes:	Design and drawing, construction/modeling
Applications:	Space habitation and experimentation
Impact:	Future living and working environment

21 Solar Heating

Activity Challenge: Students will design and construct a solar collector that heats air. Students will test and chart temperature differences under varying weather conditions.

Resources: Design and drawing equipment and materials, solar collector construction materials as specified by student design

Processes: Design and drawing, construction techniques

Applications: Heating and cooking

Impact: Energy, environment, natural resources

22 Alternate Electrical Generation Device

Activity Challenge: Students will design and construct a device that will generate electricity by using alternate sources, such as wind, geothermal, etc. Students will display and demonstrate their constructed device to the class for review and evaluation.

Resources: Design and drawing equipment and materials, modeling materials based upon student's design

Processes: Design and drawing, construction processes

Applications: Electrical generation and output devices

Impact: Ecologically cleaner environment, newer alternate energy sources

23 Comparison of Transportation Efficiency

Activity Challenge: Students will research and make a comparison of the fuel consumption, travel time, and cargo capacities of air transportation and of ground transportation. Graph and chart results of comparison indicating benefits and limitations of each type of transportation.

Resources:	Reference materials, graph and chart paper
Processes:	Research procedures, graphing and charting
Applications:	Air and ground freight transportation
Impact:	Transportation of goods, with improved timing and cost

24 Radiant Heat

Activity Challenge: Students will design, construct, and determine the most efficient materials and color coatings for absorbing radiant heat by measuring the temperature of water passing through test tubes made from copper, aluminum, and plastic tubing. The tubing will also be painted to test for the best color for heat absorption.

Resources:	Design materials and equipment, materials as required by student design, including various tubing materials, paint, thermometer, and other testing equipment
Processes:	Collection of radiant heat
Applications:	Heating of facilities
Impact:	Alternative energy source, cleaner environment

25 Space Transportation and Station

Activity Challenge: Students will design and construct model space vehicles for transporting people and materials, and model space stations. Students will display and evaluate models.

Resources: Design and drawing materials, modeling materials

Processes: Design and construction processes

Applications: Space transportation (space shuttle) and station

Impact: Exploration of space

26 Hydraulic Lift

Activity Challenge: Students will design and assemble an open-center hydraulic pump model, using syringe and tubing materials, to move or lift a 30-pound weight from point A to point B.

Resources: Design and drawing materials, modeling materials, fluid

Processes: Hydraulic leverage

Applications: Hydraulic elevators, forklift, and devices

Impact: Increased use machines

27 Regulation of Traffic Flow

Activity Challenge: Students will design and build a model of a commuter rail line. They will regulate other ground transportation through signs, schedules, and lights for the safety of the rail line and other transportation means.

Resources: Design and drawing materials, construction materials for model construction

Processes: Design and drawing, construction

Applications: Regulation and control of traffic

Impact: Commuter safety and scheduling

28 Wireless Switching

Activity Challenge: The students will design and build a remote-controlled door opener. This will consist of a transmitter, a receiver, and a mechanical door opener.

Resources: Design and drawing materials, modeling materials

Processes: Design and construction

Applications: Wireless control and switching

Impact: Security, safety, ease factors

29

Basic Electrical Detection Systems

Activity Challenge: Students will design, construct, and test a variety of electronic detection systems. Systems will use several types of switches, power sources, and indicators.

Resources: Design and drawing materials, switches, power source, conductors, and inductors

Processes: Design, construction

Applications: Electrical detection, alarm systems

Impact: Security, and fire protection

30

Testing Electrical Systems

Activity Challenge: Students will use common electrical testing equipment, ohmmeter, ammeter, and voltmeter. Students will diagnose current flow, resistance, and voltage in common electrical circuits. Basic components, such as resistors, capacitors, and transistors, will be introduced to the students.

Resources: Testing equipment, basic wiring and electrical components

Processes: Testing, diagnosis

Applications: Troubleshooting, awareness and identification of electrical components

Impact: Literacy of electrical circuits and components and testing equipment